MACHINE DESIGN

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CONTENTS

Page

Tiny Mechanisms—Big Design Problems 21
By M. F. Manby

Scanning the Field for Ideas 25

Oil Filters Insure Clean Supply of Liquid 28
By Allen F. Clark

Guard Against Fatigue Failures Caused by Design 32
By A. V. de Forest

Welded Shapes, Alloy Castings Reduce Weight 35

How To Compare Load Ratings of Antifriction Bearings 36
By J. L. Haynes

Dynamic Load Governs Gear Steel Choice 39
By V. M. Faires

Design Features in New Machines 42

New Machines Indicate Design Trends 44

Utilization of Agricultural Products Means New Machinery (Editorial) 45

Men of Machines 46

Professional Viewpoints 48

Noteworthy Patents 54

New Materials and Parts 58

Manufacturers Publications 75

Research Publications 77

Business Announcements 78

Topics 18

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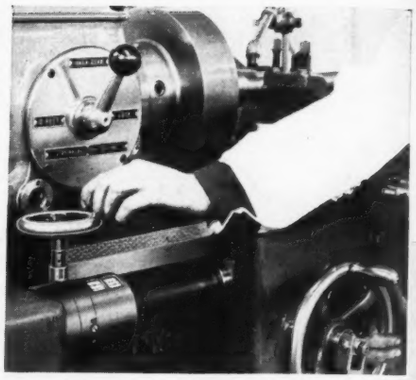

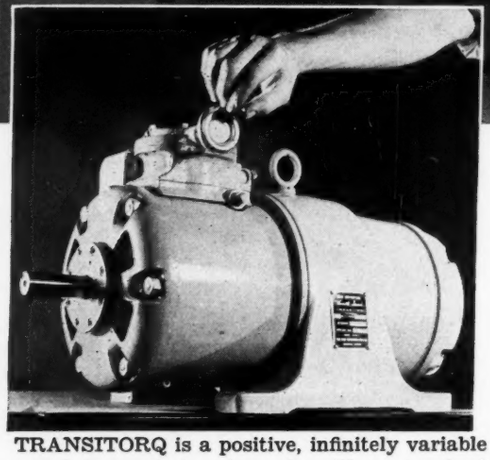

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Itemized Index

CLASSIFIED FOR CONVENIENCE WHEN STUDYING SPECIFIC DESIGN PROBLEMS

Design Calculations:

Bearing ratings, Edit. 36, 37, 38
Gear strength, Edit. 39, 40, 41L

Design Problems:

Bearings, comparing rating of, Edit. 36, 37, 38
Fatigue limits, determining, Edit. 32, 33, 34
Filters, applying oil, Edit. 28, 29, 30, 31, 73L
Gears, calculating strength of, Edit. 39, 40, 41L
Hydraulic and electrical controls, combining, Edit. 26
Interchangeability, insuring, Edit. 22L
Minute accuracy, obtaining, Edit. 21, 22, 23, 24, 50R
Oil, insuring cleanliness of, Edit. 28, 29, 30, 31, 73L
Steels, selecting for gears, Edit. 34, 40, 41L
Weight, reducing, Edit. 35, 71L, 72R
Welding, designing for, Edit. 35, 71L, 72R

Finishes:

Paints, Adv. 19

Materials:

Alloys (Nickel), Edit. 24R; Adv. 57
Alloys (Steel), Edit. 71L, 72R; Adv. 12, 13, 16, 61
Brass, Edit. 24L
Bronze, Adv. 20
Felt, Adv. 64L, 78L
Jewels, Edit. 50R
Magnesium, Adv. 20
Molybdenum, Adv. 53
Plastics, Adv. 68L
Steel, Edit. 34, 39, 40, 41L
Zinc, Adv. 82

Mechanisms:

Abraiding, Edit. 48, 50L
Balance wheel, Edit. 23R, 24L
Clutch, Edit. 52R, 54R
Driving, Edit. 54R, 56R
Escapement, Edit. 23R
Solenoid, Edit. 26R
Torque converting, Edit. 25R, 26L

Organization and Equipment:

Engineering department, Adv. 73R, 75R

Parts:

Bearings, Edit. 23R, 36, 37, 38, 60R, 62R; Adv. 49, 52L, 59, 63, 65, 71R, 76L
Cast parts, Edit. 71L, 72R
Clutches, Edit. 26L, 52R, 54R; Adv. 62L
Connectors, Edit. 66R
Controls (Electrical), Edit. 26; Adv. 3, 15, 84
Conveyors, Edit. 26L, 58R, 60R
Counters, Adv. 51
Couplings, Edit. 62R; Adv. 74L
Drives, Edit. 25R, 26L, 54R, 56R, 68R; Adv. 6, 54L, 56L
Electronic equipment, Edit. 27
Fastenings, Edit. 24L; Adv. 2, 79R, 81, 83
Filters, Edit. 28, 29, 30, 31, 73L
Forgings, Adv. 67
Gears, Edit. 23R, 26L, 39, 40, 41L; Adv. 14, 66L, 78L
Hose, Edit. 66R, 68R
Hydraulic equipment, Edit. 26
Lubrication and lubricating equipment, Edit. 28, 29, 30, 31, 72R; Adv. 74L
Motors (see also under Drives), Edit. 68R, 70R; Adv. 9, 10, 11, 17, 55, 58L, 60L, 70L, 75R
Nozzles, Edit. 64R
Packing glands and packing, Adv. 4, 77R, 80L
Plates, Edit. 70R
Pulleys, Edit. 70R, 71L
Pumps, Edit. 58R, 62R, 64R, 66R; Adv. 64L, 68L, 70L, 72L, 80L
Shafting, Adv. 72L, 76L
Shims, Adv. 66L
Springs, Edit. 23R, 50L
Welded parts and equipment, Edit. 18L, 35, 71L, 72R; Adv. 8

Principles:

Hydraulic, Edit. 26
Vacuum, Edit. 26R, 27L

Production:

Securing precise, Edit. 21, 22, 23, 24, 50R

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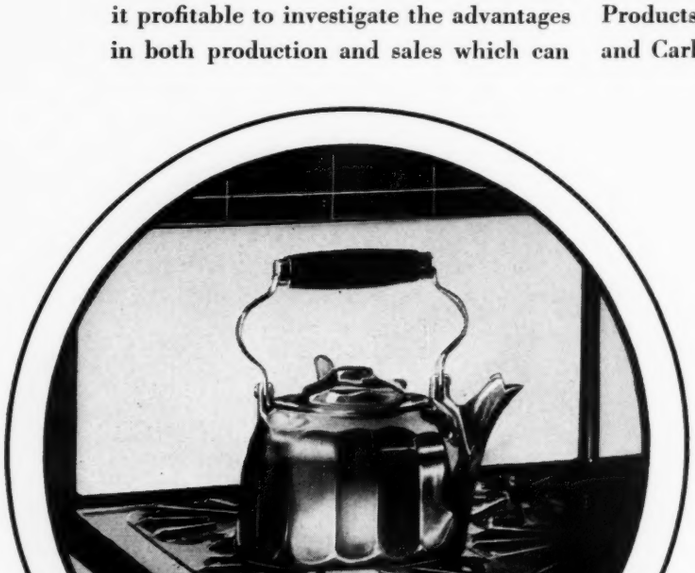

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Topics . . .

WELDING technique is advancing so rapidly that the designer must constantly instruct himself in the new developments. The latest step in this advance is the perfection of a low-temperature welding process, termed by Robert E. Kinkead, consulting welding engineer, as a development which promises to be the most important in welding in the last 25 years. As an example of the process, two pieces of 28-gage stainless steel have been welded together perfectly with the temperature during welding not exceeding 700 degrees Fahr. This weld shows a tensile strength within one-tenth of one per cent of that of the base metal. A high-frequency current serves as a sort of "molecular hammer" and, when applied after the metal has been heated to a specific temperature, breaks down the molecular attraction in edges of abutting pieces and they weld together.

• • •

Another welding advance is signalized by the announcement of a system whereby a number of welders may work from a single machine. This method simplifies large production and makes this production possible more economically and in less space.

• • •

Contact between adjacent cars under all conditions of curvature or draft gear movement is maintained on the new Mercury train by a full width diaphragm or closure arrangement especially developed for this job. This closure is supported by a full width buffer casting at the bottom and by a spring-actuated plunger at the top. The entire structure, which includes metal telescoping diaphragm around passageway between cars, is top-supported by spring cushioned rods anchored to the end of the car, each side, and is otherwise guided and cushioned so as to insure quiet and smooth operation under all conditions.

• • •

This train further follows the modern trend by including complete air conditioning. Rubber or fabric pads are used over and under truck springs under all wear plates and side bearings and at other points in order to break metallic contacts, provide cushioning means for absorbing all shocks, and to prevent vibration and thus reduce noise. In keeping with these developments, the interior has been designed like a private club with warm tones of brown and rust contrasted with varied light shades of tan and distinctive gay greens and blues. Varying shades and hues of S-W paints are employed to tie each car into the composite whole yet maintain individuality in each layout.

• • •

As its activities have become closely allied with engineering branches of the steel industry in addition to the electrical, the Association of Iron and Steel Electrical Engineers will change its name on Aug. 1 to Association of Iron and Steel Engineers.

• • •

Designers who must watch their production costs will be interested in the forthcoming announcement of a new cutting metal which is said to fall between the cast and cemented types as to general characteristics and to cost only a fraction of the cost of cemented tungsten carbide.

• • •

The ingenuity of designing engineers is not limited to the standard development of production, office, domestic or any of the other usual lines of machinery. Many engineers who have let their imaginations ride have been able to see possibilities of developments that materially aid science, work or play in a manner that could not possibly be foreseen by less active thinking. One of these machines not only makes it possible to enjoy

(Concluded on Page 74)

MACHINE DESIGN

Tiny Mechanisms— Big Design Problems

By M. F. Manby
Chief Engineer, Hamilton Watch Co.

IN DESIGNING a new watch mechanism the most important factors to consider are, in the order of their importance, timekeeping accuracy, interchangeability, sturdiness, accessibility and adaptability to manufacturing methods. Accuracy being the basis of all fine watch design, it is necessary in this industry to correlate design and production to an extremely intimate degree. Minute size of parts, close tolerances demanded, limitations of space in which the mechanism must function—all these contribute to the production problems which at Hamilton Watch Co. are worked out by the chief engineer as part and parcel of his design duties.

Design methods in this industry deviate somewhat from orthodox practice. From the time the watch is conceived and worked out on the drawing board until it emerges as a finished mechanism, ready to be added to the standard line, as much as two years may have elapsed. The cost of development work during this period often reaches as high as $100,000. When the almost innumerable drawings have been completed, they are turned over to a corps of experts in the "model room", who proceed to make each part by hand. These hand-made parts are carefully checked and it then becomes the task of the engineering department to work out the problems involved in mass production of the new model.

As a thought with regard to timekeeping accuracy, it might be interesting for designers of other mechanisms to compare the per cent of accuracy of a watch with the per cent of accuracy of other measuring instruments. For example, a wrist watch ticks 5 times a second, or 18,000 ticks per hour, or 157,680,000 per year. If a watch does not vary more than 30 seconds per week it has not varied more than 150 ticks in 3,024,000 and is, therefore, accurate to approximately one part in 20,000. The timekeeping unit in a watch is the hairspring and balance wheel combination and the constancy of its period determines the accuracy of the watch. The period of this vibrating unit is effected by position, amplitude of vibration, friction, tempera-

Fig. 1—This wrist watch has 178 parts and all but the hair spring are interchangeable

ture, magnetism, humidity and acceleration. With all these factors to consider, it is apparent that the problem of timekeeping accuracy is the most important thing to consider.

Watch repair and cleaning often require complete disassembly, consequently the more the designer can facilitate this the easier it will be for the repairman to maintain the accuracy that was originally built into the watch. Interchangeability and accessibility are thus features of utmost importance. The new Hamilton wrist models, one of which is shown in *Fig.* 1, have these features. With exception of the hairspring all parts including plates and bridges of nickel silver, jewels and pinions are perfectly interchangeable with other parts of the same grade.

With regard to the factor of sturdiness, the designer must keep in mind that the mechanism must be so constructed as not to be impaired in the process of assembly or repair and must withstand at least 365 windings per year for many years. When one considers that a balance screw on the balance wheel travels approximately 4000 miles per year, supported by balance pivots as small as possible to reduce friction, yet sturdy enough to withstand ordinary misuse when carried in the pocket or worn on the wrist, the importance of this cannot be overemphasized.

Adaptability to manufacturing methods sometimes offers the greatest problems due to the fact that it is desirable to design the largest possible moving parts within the given space limitations determined by size and style of the finished watch. Locations of holes must be so distributed that the elements of the various piercing and shaving dies can be made as rugged as possible. In designing larger mechanisms the designer seldom has to take into consideration the effect of a burr caused by a subsequent processing operation. In the case of a watch a burr caused by machining or grinding might be large enough to affect the timekeeping accuracy of the watch and, therefore, the designer must keep in mind the shape and size of the parts and the manner in which they will be processed so that burrs will be kept to a minimum. Holes must be arranged and shapes of recesses must be designed so as to keep down distortion during the course of manufacture.

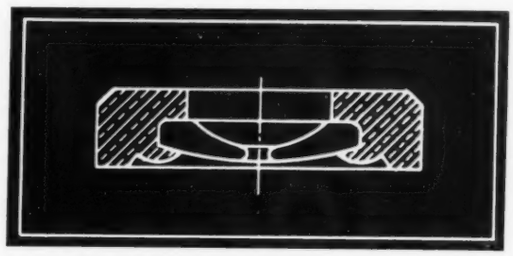
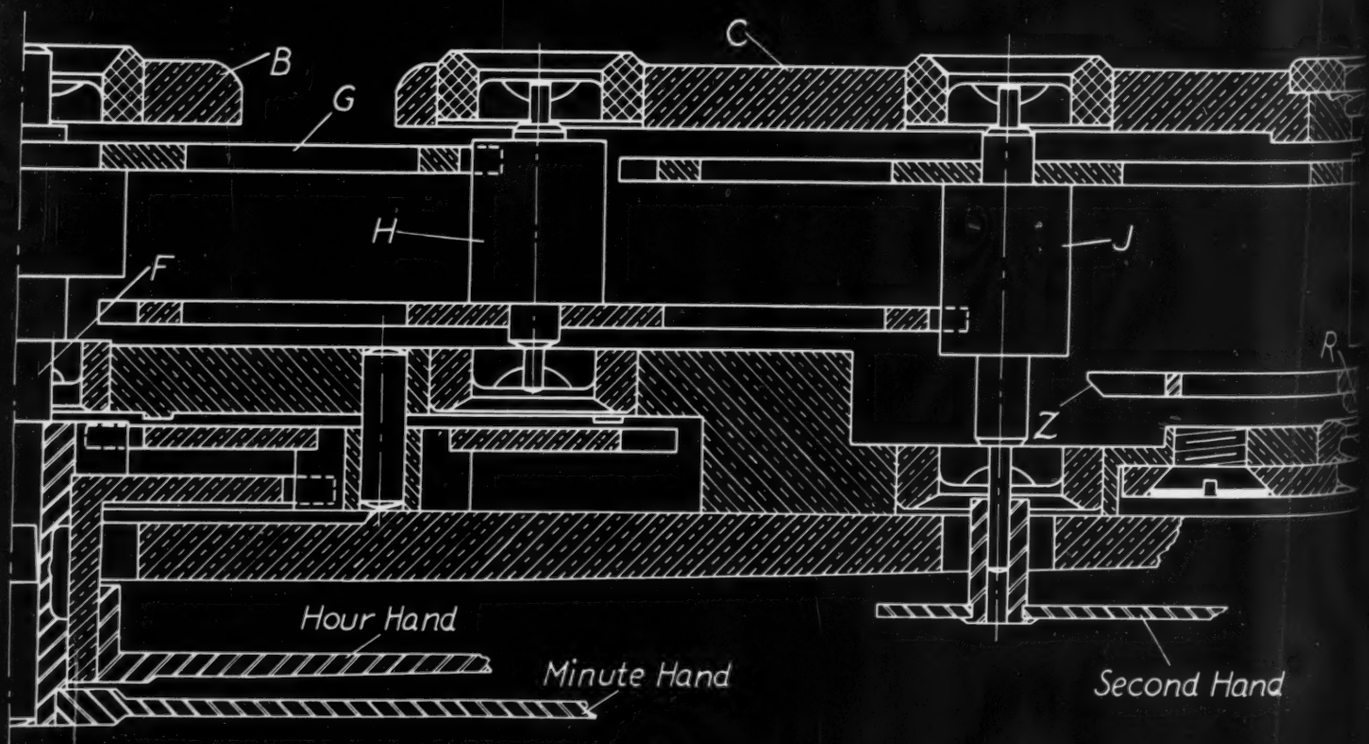


Fig. 3—Cross section of type of "jewel" and setting used for balance staff and escape wheel bearings

Everyone is more or less familiar with a watch mechanism, yet it may prove interesting to describe briefly the operation of a "movement". In *Fig.* 2, a portion of a cross-section through the wrist watch shown in *Fig.* 1, it will be seen

Fig. 2—Cross section, approximately 18 *times full size, of that half of wrist watch "movement" embodying the escape mechanism and power train to hands*



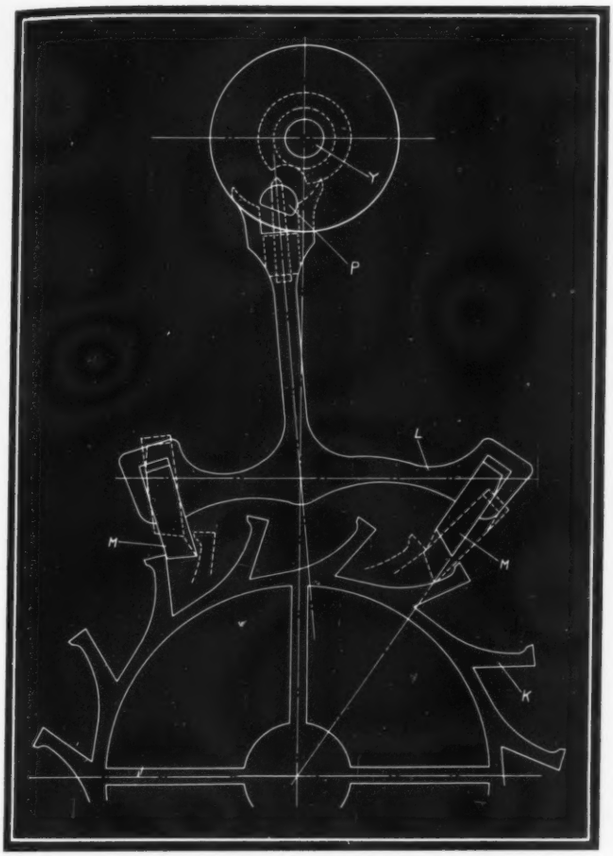


Fig. 4—The escape mechanism is governed by the balance wheel to release energy from main spring at exact intervals

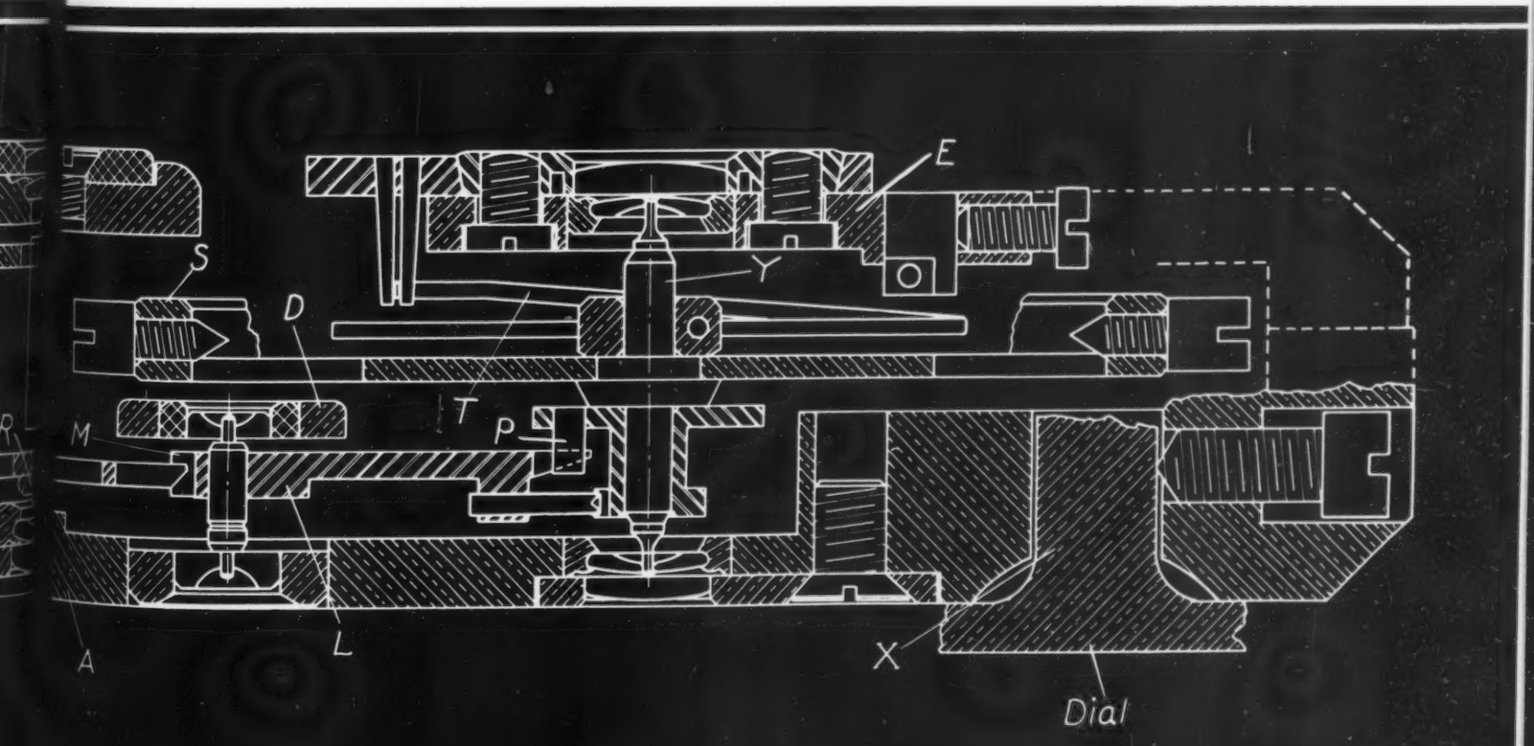
that the system of gears and wheels is carried on a pillar plate *A* which embodies the bearings for one end of the shaft. Bearings for the opposite ends of these shafts are set in a barrel bridge *B*, a train bridge *C*, pallet bridge *D* and balance cock *S*, these being parts that are easily removed to facilitate disassembly. A mainspring, not shown, actuates the train through teeth on the barrel in which it is housed.

Energy stored in the spring through winding is imparted by the teeth on the barrel to a pinion on center shaft *F*, through center gearwheel *G* to a third pinion *H*, through the third wheel to the fourth pinion *J*, thence through the fourth wheel to the escape pinion and the escape wheel *K*, as shown on *Fig.* 4.

Energy at Uniform Rate

The escape mechanism, the heart of the watch, *Fig.* 4, releases the energy carried through the train, allowing it to escape at a uniform rate. The escape wheel *K*, *Figs.* 2 and 4, is blocked by either of two arms of the pallet *L*. As one arm is pushed out of the way by a tooth of the escape wheel the other arm, after a brief interval, intercepts another tooth. Length of time that each arm of the pallet *L* alternately remains in contact with the teeth of the escape wheel *K* is determined by the tension applied by the coiling and uncoiling of the hairspring *T*, *Fig.* 2, which functions in conjunction with balance wheel *S*. The fork end of the pallet transmits the oscillations of pallet *L*, to the balance wheel assembly *Y*, *Figs.* 2 and 4, by means of jewel pin *P*. In designing the escape wheel, *K* chamfers *Z*, *Fig.* 2, have been specified for the teeth to reduce the surface which comes into frictional contact with the pallet stones *M*, *Figs.* 2 and 4.

As mentioned before, the balance wheel unit



embodying the hairspring controls the escapement, this effect being a result of the interchange of kinetic and potential energy in the balance wheel and hairspring. Potential energy is stored in the spring and the kinetic energy is a function of the balance wheel.

When it is considered that a watch is made up of approximately 178 parts, 50 of which undergo motion, and that the total number of the manufacturing operations involved is at least 1500, some idea of the design problems that accompany watchmaking becomes apparent. Many of the parts are so small that a powerful magnifying glass is necessary to examine them in detail. Every available ten-thousandth of an inch must be utilized in the watch to attain the compactness that characterizes the new mode. For instance, the balance wheel *S, Fig.* 2, swings between the third and fourth wheels, visible in *Fig.* 5, with a clearance of only 0.006 inch.

The pillar plate *A, Fig.* 2, is the largest single piece in the mechanism. This is blanked out of strip stock. Five different surfaces of varying heights and diameters are machined in it, dimensions between faces being held to within 0.0005 inch.

No part of a high-grade watch is stamped out in finished form. The gears are punched from strip brass, five sections are removed to provide spokes, but in a subsequent operation the teeth

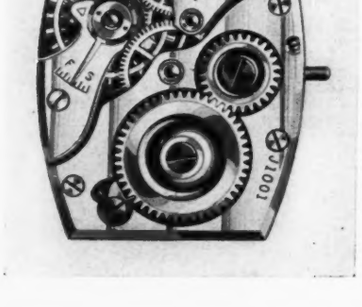


Fig. 5—Small screws are adjusted in rim of the balance wheel to make its inertia suit the strength of the hair spring

are accurately cut, about 30 wheels being milled at one time.

Another instance of design as it effects production is exemplified by specification of a hole drilled and reamed to a diameter of 0.0072 inch. This is performed in the center of the hub of the escape wheel, *R, Fig.* 4, by a bench turret lathe. Screws for the balance wheels also are striking examples of minuteness. The thimble, *Fig.* 6, holds 7800 of them. Screw machines designed solely for this purpose turn, thread and cut off these minute parts. Threads, 260 to an inch, are cut on stock 0.014 inch in diameter in the production of these screws.

The balance wheel, into the rim of which these tiny screws are placed, can be seen in the upper left of *Fig* 5. Proper positioning of these screws establishes the necessary relationship between the inertia of the balance wheel and the strength of the hairspring. Also the exact location of these screws determines to some extent the temperature compensating qualities of the vibrating assembly.

Holes for the screws in the balance wheel, *Fig.* 5, are 0.010 inch in diameter and are drilled by a two-spindle horizontal drilling machine. The 22 holes are produced at a speed of 50 pieces per hour. A 0.0128-inch, 260 thread tap on a single horizontal spindle machine furnishes 2860 holes per hour.

Pivots on the balance staff *Y, Fig.* 2, constitute

Fig. 6—Screws used in rim of balance wheel are so small that a thimble will hold about 7800 of them

what would be called journals on a large shaft. This part is 0.167 inch long and pivots are each turned to a length of 0.013 inch with a diameter of 0.0046 inch with limits of 0.0002. This shaft is turned from cold drawn .90 carbon steel wire in an automatic screw machine.

In Hamilton watches the balance wheel and hairspring unit, *Figs.* 2 and 5, vibrates 18,000 times per hour. Inasmuch as these vibrations must not vary, it is essential that the hairspring be of exactly the right length, width and thickness. In selecting a material that would meet the requirements of accuracy, the engineering staff adopted Elinvar for the hairspring and a monometallic balance wheel, shown in section at *S, Fig.* 2. Thus it has been possible to attain automatic temperature compensation for the watch movement, as this nickel steel alloy does not change its elasticity when subjected to temperature changes. Because Elinvar is rustless, corrosion at this vital point has ceased to be a problem. The balance and balance arm, being a hard nonferrous alloy, are non-magnetic. Therefore they do not attract the hairspring. This spring, although it is an alloy of steel, cannot be permanently magnetized.

Other materials that play important practical parts in watch design are precious stones—rubies

(*Concluded on Page* 50)

Scanning the Field . . . FOR IDEAS

AN EXAMPLE of interplay between science and engineering was cited by Dr. Robert W. Wood of Johns Hopkins university at the Spring meeting of the National Academy of Sciences in Washington. It was in connection with the laboratory problem of production of diffraction gratings used in spectroscopic analysis. These gratings ordinarily are true planes of speculum metal or glass on the highly polished surface of which from 15,000 to 30,000 lines per inch are scribed by a diamond tool in a ruling machine. Unless these lines are parallel, uniform and exactly spaced, the gratings are unsatisfactory.

Uniform ruling directly on the hard metal or glass surface is next to impossible. To get around this difficulty, Dr. Wood has adapted a method developed for making telescope mirrors. First, he deposits on the plane surface of a glass plate a thin, uniform coating of the hard metal chromium, and on this in turn he deposits a film of the softer aluminum. Deposition is accomplished in a vacuum, metallic vapor being "boiled off" an electrically heated coil. Following this preparation, it is necessary for the diamond tool to cut only through the thin uniform film of soft aluminum, and therefore Dr. Wood now is able to scribe 210,000 lines on a 7-inch grating—this to a degree of perfection never before attained.

Earlier Practice Points the Way

From the engineering point of view, several things in this laboratory accomplishment are significant. In the first place, the precision ruling machine used in this work developed out of practical experience in machine design and machine shop practice. Furthermore, the method of producing absolutely plane surfaces on the grating plates is essentially that which long has been followed in generating true surfaces on cast iron surface plates used in machine shops and more recently in finishing precision gage blocks. On the other hand, science in this case is making its contribution to industry. The diffraction grating is an important factor in the light wave system of measurement now applied in fine interchangeable manufacturing.

ECCENTRICITY GIVES SPEED VARIATION

SEEKING to attain torque conversion in approximately inverse proportion to the speed change in a compact mechanism, H. B. Greening and J. B. Galloway of Hamilton, Ont., have worked out the design of which *Fig.* 1 is a section showing some of the most interesting of the working parts. This is intended for industrial as well as automotive use.

This transmission operates on the variable throw principle. The driving shaft is made to give either smaller or larger angular impulses

Fig. 1—*Variable throws and mechanical valves are employed to give changes in speed*

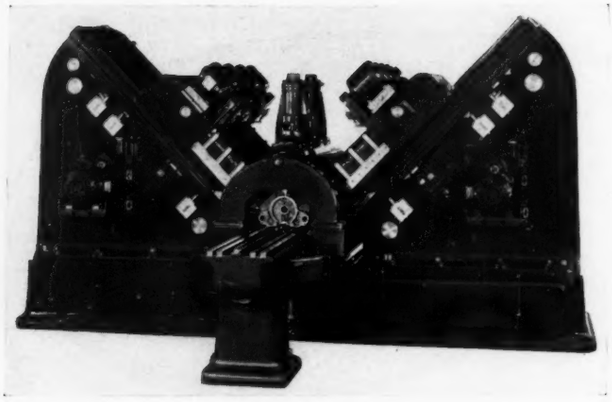


Fig. 2—Mechanical, electrical and hydraulic systems work together in automatic cycle

to an intermediate member. These power impulses, which are in such rapid succession as to be to all intents and purposes continuous, are delivered through what can be called a mechanical valve. Where the torque is comparatively light the valve is a roller clutch, but when torque is heavy a coil-type clutch is used.

When in action, rotation of the crankpin (1) around the axis of the driven member causes the shoes (5) on the arms (3) progressively to grip the gear ring (7) through the medium of pinion and gear teeth and overrunning spring clutches in the pinions.

As the shoes grip the stationary gear ring, a sleeve (2) on the crankpin is revolved, this revolving effect being imparted to a second set of pivotal arms (4), whose movement in turn is transmitted through clutches and pinions to an internal gear ring connected to the driven shaft. The ratio varies according to degree of eccentricity of the crankpin in relation to the crankshaft, which can be changed by a shift lever which actuates a shifter collar. While there is a slight effect similar to the overlapping power impulses of a multiple cylinder engine, the flywheel effect of the driven end smooths out the output power flow.

CO-ORDINATING MACHINE CONTROLS

DESIGNED for use on V-type engine blocks the Ex-Cell-O boring machine, of which a rear view is shown in *Fig.* 2, embodies an interesting combination of mechanical, hydraulic and electrical features of unit type co-ordinated to give an automatic safety cycle. When the starting lever at the front of the machine is moved to first position, a motor-driven work conveyor carries two cylinder blocks into the holding fixture. When this lever is moved to second position, pins locate the blocks at the bottom, hydraulically-operated clamps bind them down from above, and pressure switches in the top of the fixture close, starting the boring slides in rapid traverse.

As the tools enter the work, the slides slow down to cutting feed and limit switches below each slide start the eight individual spindle motors. Should any one of these fail to start, other motors which drive the hydraulic feed systems of both slides stop automatically, or should a block not be properly located and clamped, the boring phase of the cycle will not begin.

When the spindle motors start, a solenoid withdraws a lock from each spindle. At the end of the bore, limit switches stop the spindle motors, solenoids are de-energized to release the spindle locks, and another limit switch starts the spindle motors slowly in reverse. At the end of this return stroke the cylinder blocks shift to bring alternate holes into boring position. Due to close center distances all holes cannot be bored at once. By loading two blocks for simultaneous boring, the two are finished at the end of the second cycle, which duplicates the first. When it ends, the fixture returns to loading position, and with initial back throw of the control lever, the blocks automatically move through the fixture to loading position. With a second back throw of the control lever, hydraulic clamps release, locating pins withdrawn and both finished blocks move completely out of the fixture as two unfinished ones move in.

VAPOR GIVES VACUUM SEAL

VACUUM sealing of milk bottles is accomplished on a commercial scale by the machine shown in *Fig.* 3. This machine and process, developed by the White Cap Co., Chicago, makes use of lacquered metal caps which fit over the

Fig. 3—A puff of vapor expels air under the caps, which are held down by vacuum

rim of the bottle and which have rubber gaskets to complete the seal.

The method of inducing the vacuum under the cap is rather unique. After filling a bottle, and just before one of the metal caps is lowered into position, a jet of vapor displaces the air under the cap. The cap then seats itself, and with the condensation of the vapor in the small space below it, the cap is sucked down and held down firmly.

PROTECTING THE OPERATOR

IN THE cold room of an ice cream plant, a temperature of 48 degrees below zero Fahr. usually prevails. It therefore is impossible for a worker to remain inside for any extended period.

With the adoption of mechanical handling methods in the cold room, the problem of watching the conveyors arose. For instance, when two feeder conveyors supply one outgoing line from the cold room, there is a possibility that too many containers will become concentrated on the outgoing line, thereby clogging it.

Westinghouse Electric & Mfg. Co. recently installed the photoelectric tube device shown in *Fig.* 4 to "watch" and report on conveyor conditions in a cold room. Two light sources and photo-housings are placed across the output conveyor line. In case congestion occurs, both beams are intercepted and the two contactors for the two photoelectric relays outside the cold room combine in operating one alarm. When this happens, a worker immediately puts on heavy coat and boots and enters the cold room to clear up the situation. There is little if any loss of time either for mechanism or worker, serious jams are prevented, refrigeration losses are reduced, and workers are relieved of long exposure to the intense cold, because the electric eye functions the same under frigid conditions as it does under normal temperatures.

Fig. 4—Even at 48 degrees below zero the electric eye watches unceasingly for "traffic jams"

Fig. 5—Workmen have more respect for machines when they know "cost installed"

PLATE EMPHASIZES MACHINE COST

DESIGNED originally to facilitate the keeping of plant records, a special data plate for attachment to Monarch lathes has turned out to be decidedly influential toward increasing pride in workmanship on the part of machinists using the lathes and toward improving employe relations in shops where the machines have been installed.

As will be noted from the illustration, *Fig.* 5, this special plate includes—along with other pertinent data on the machine—its "cost installed" figure. That is the vital point. Workmen who are worthy of the name long have been known to react favorably to good equipment, but it is a fact that their ideas as to the actual cost of such equipment generally have been vague and in the majority of instances have tended toward the "low side."

When, after a glance at one of these plates, they realize that the management actually has entrusted to their care a piece of equipment costing let us say $3000, the job immediately assumes the nature of a trust rather than a task. Also, there develops a feeling that the management is taking the workman into its confidence to a greater degree than ordinarily had been the case in "old line" shops.

The foregoing statements are not based on theory but on actual experience, as a result of which several hundred of these special plates have been made up and are being distributed to users who have seen the practical effect of this simple expedient. Having proved its value on machine tools, this type of plate should interest builders and users of a wide variety of other industrial equipment, inasmuch as respect for machines is worth cultivating in any line.

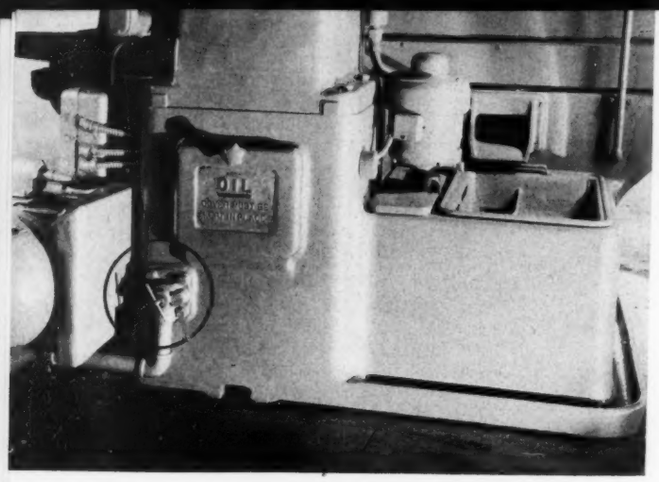


Fig. 1—Oil employed in this hydraulic vertical surface grinder is kept in good condition by continuous circulation through a filter. Cleaning of the filter is by hand whenever this is necessary

Oil Filters Insure C

By Allen F. Clark

WIDESPREAD use of centralized lubricating systems, the more universal acceptance of hydraulics, and the application of diesel power have been rapidly increasing the importance of taking adequate steps to protect the cleanliness of the oil by the use of filters. In many instances the combination of hydraulic and lubricating systems makes the provision of an adequate filter doubly important as affecting not only the bearing surfaces, but also the operation of the hydraulic control mechanism.

Economical maintenance of a diesel engine requires, more than anything else, a fuel oil free from impurities or solids which would have an abrasive effect upon the fuel oil equipment. This may be accomplished by a filter installed directly upon the engine which is capable of so purifying the oil that it will be absolutely free of impurities and no trouble will be experienced either by scoring the honed surfaces of the injector pumps or clogging the nozzles. *Figs.* 2*A* and 4 show applications of this type.

Insures Safe Lubrication

The use of an oil filter insures safe and adequate lubrication for all running parts, an especially important consideration in view of the higher speeds and greater efficiency demanded of today's machines. Oil filters remove from the lubricant those particles of foreign matter which experience has shown are present under operating conditions in spite of the most careful refining and handling, and which must be especially guarded against in hydraulic systems where the oil is used over and over again. Filters used in lubrication systems are shown in *Fig.* 2, *B* and *H*, and in *Fig.* 6 where the unit guards the lubricating oil of a diesel engine. In Fig. 4 a filter which cannot be seen is used in the lubricating system, the unit shown cleaning the fuel oil on this diesel engine. Hydraulic installations are shown in *Fig.* 1 and in *Fig* 2*C*.

While this article principally considers filters to be used in the cleaning of oil, it must be remembered that many machines use these filters for guarding entirely different substances. An example of this is shown in *Fig.* 3. Manufacturers of fine coated papers make much second grade product because lumps of clay, gum, metal coating or lacquer get caught between the rolls and cause spots and streaks. The motor-driven filter

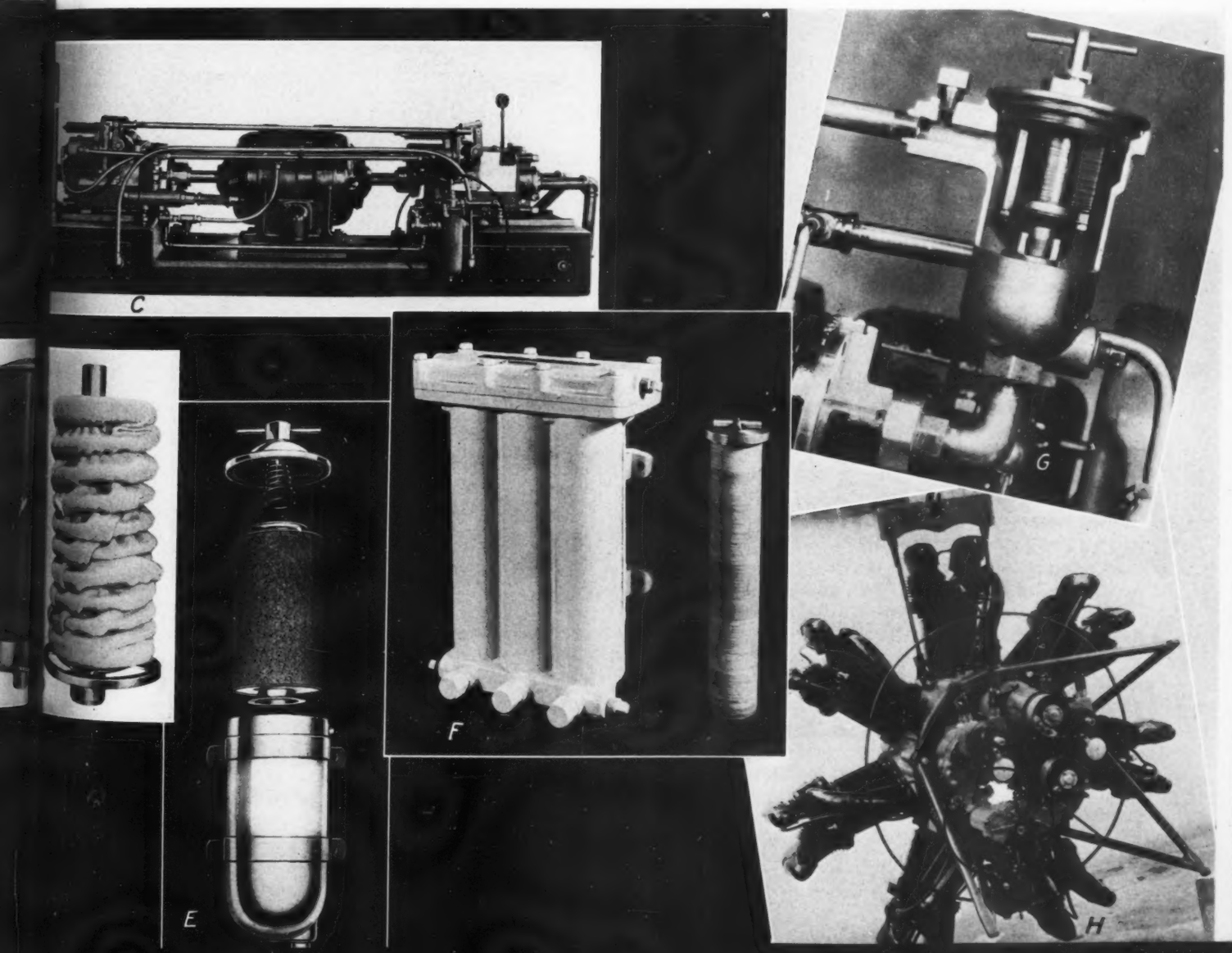
Clean Supply of Liquid

shown on this reverse roll coater aids considerably in the reduction of number of seconds.

Filters as an integral part of the machine not only insure the manufacturer that every danger has been guarded against to give his machine maximum trouble-free life, but materially benefit the user. The advantage to the user of such a machine is that the manufacturer naturally provides for filter installation in a place most easily accessible so that necessary cleansing shall consume as little time and as little labor as possible. In installing a filter as a part of the machine the manufacturer also has in mind the elimination of leaks which might occur in unnecessarily long tubing, and many manufacturers have found it good practice to include the filtering element in the casting of the oil circulating system.

Filters may be built into the machine either

Fig. 2—A—Scoring of honed surfaces in engine by impurities in diesel fuel is prevented by filtering. B—Gasoline engines also benefit by treatment of lubricating oil. C—Hydraulic pump directs oil through the filter in this installation. D—Two types, extended fabric element and metal-edge element are applied for varying jobs. E—Special igneonite element cleans the oil. F—Paper washers stacked together stop the passage of foreign substances. G—Domestic oil burner application shows construction of filter which consists of a stack of perforated disks. H—Full flow installation protects aircraft lubricating oil



directly at the oil reservoir or at any other convenient point through the provision of a simple sump or pocket in the machine casting. This avoids external connection and piping and makes for a "clean" design. Usually only the head flange is in evidence as shown by *Fig.* 1.

In considering the application of a filter to any machine, close attention must be given, of course, to the viscosity and volume of the oil to be handled, and a unit must be selected which will provide a sufficient free area so that the velocity of oil through the filter will fall within the limits recommended by the makers of the units. The matter of size is of paramount importance. The filtering element should be large enough to accommodate the flow rates with a wide margin of safety. Sump capacity should be sufficiently large to accommodate considerable accumulation of contamination so as to make cleaning necessary as infrequently as possible. Easy methods of draining and collecting foreign matter are, of course, important.

Location is another vital point that should be decided early in the design. The general recommendation is that oil filters should be installed on the pressure side of the pump.

Don't Insist on Fine Spacing!

These recommendations for application can best be summed up in a series of "don'ts." Don't put a filter on the suction side of the oil pump, unless there is an unusually sound reason for doing so. Don't make the element too small. Don't insist on fine spacing in the case of special elements, use the spacing recommended by engineers of the manufacturer and increase the area of the filter to reduce velocity through the unit. Don't put the filter where it cannot be easily cleaned and drained.

An oil filter is not recommended where the machine speed and type of bearing used require only occasional lubrication and a limited quantity of lubricant or where the layout of the machine is such that a centralized pressure system with continuous circulation is not practical from a mechanical viewpoint. When oil is the liquid to be treated, however, it is rare when conditions suggest the inadvisability of using a filter. Such negative conditions have appeared where extremely high pressures have been involved because the expense of making filters to withstand pressures of more than 1000 pounds per square inch rises rapidly above ordinary costs. Heat, as well as pressure, is sometimes a consideration militating against filter use, but some filters are now constructed to withstand temperatures as high 400 degrees Fahr.

As can be appreciated from the foregoing, a wide variety of oil filters is available. Although all of these types are designed for the same purpose and operate along similar lines, they differ greatly in construction. Details of these constructions will undoubtedly be of interest to engineers.

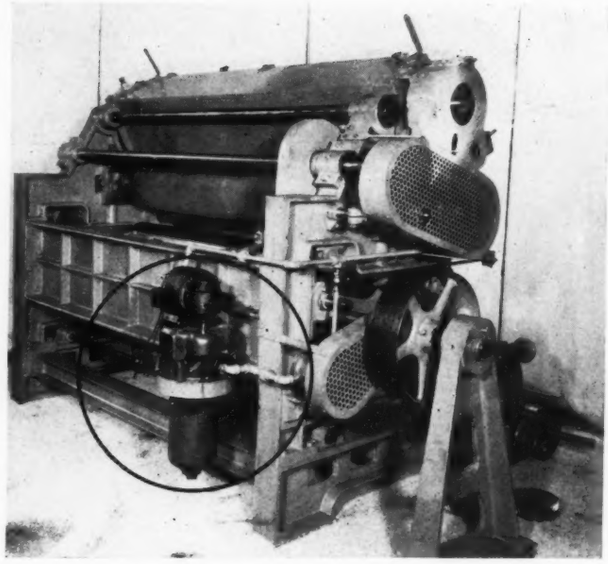
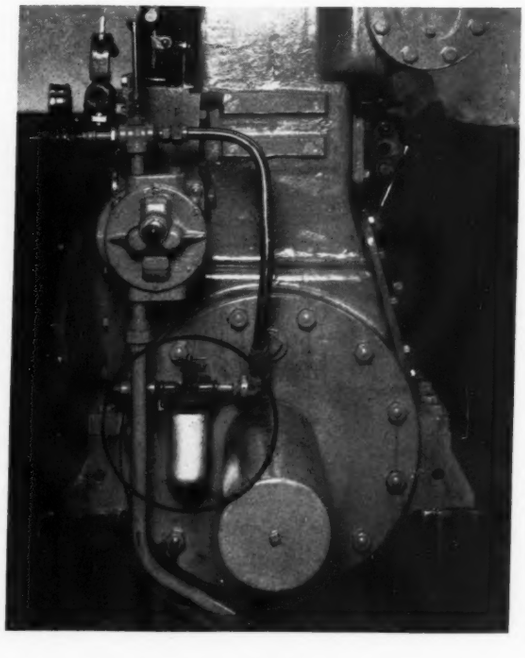


Fig. 3—*Lumps of clay, gum, etc., are kept from between the rolls on this reverse roll coater by the use of a motor-driven filter*

Fig. 4—*Two filters are employed on this diesel engine, the one shown cleaning fuel oil, while another inside the engine guards lubricating oil*



A type widely used as a built-in element on machines consists of a stack of round, thin, perforated disks, each one separated from the other by a very thing metal spacer, the thickness of the spacer determining the fineness of filtration. This unit is shown in *Fig.* 2*G* as adapted to a domestic oil burner. When the assembly of the

cartridge is complete, it is drawn tightly together and locked in place by a solid closing washer at the bottom end. The liquid to be filtered enters the filtering cartridge from the outside, passes through the fine spaces or slots between the disks, goes up through the interior of the disks and passes out through the outlet pipe.

Thus any solids larger than the thickness of the spacers are held back by the edges of the disks. Then as the disks are revolved by means of an outside handle on top of the filter, stationary cleaning blades, extending across the rim of the disks and so shaped that they push outwards any particles which come against them as the cartridge is turned, scrape the cartridge clean and open the filtering slots. When the disks have been turned through one complete revolution the filtering slots must be clean; solid matter drops and settles to the bottom of the sump chamber where it may be occasionally removed through an outlet in the base of the sump. Turning of the handle may be through manual or mechanical means. It may be turned as often as desired without damage to the unit.

Arrangements for mounting this type of filter should be made so that mechanical turning is provided or that the filter handle is accessible for turning and is in a position where it is not likely to be overlooked in the course of the normal operation and servicing of the machine. Provision should be made for draining the filter sump when servicing or overhauling the machine.

It is common practice to mount this type of filter with the element in a horizontal position *Fig.* 1, and where this is done the mounting should be arranged so as to bring the cleaner blades underneath the element in order that the foreign material combed out and compacted by the cleaners may fall clear of the filter element. It is desirable in these installations that a pressure gage be incorporated in the line beyond the filter as a check on the oil flow and, in the case of a manually operated filter, as indication of the necessity of turning the filter handle.

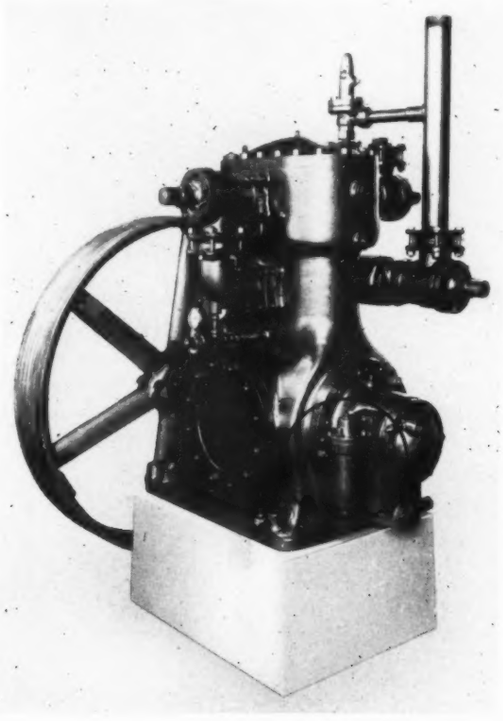
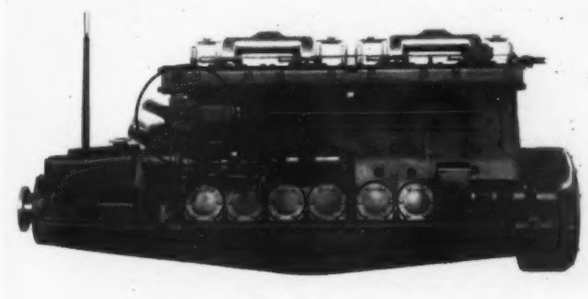


Fig. 5—Application on freon compressor is conveniently located, permitting simple and certain maintenance and cleaning

Fig. 6—Diesel engine lubricating oil, sharing importance with the fuel oil, must also be protected by a filtering device



Fabric Elements Employed

A second design of filter is made in two types, *Fig.* 2*D*, one with a fabric element of extended area construction; and the other with a metal-edge element. In the case of the fabric element filter, each drop of oil passes through the filtering element at a pace about equal to that of the hour hand of a watch. The large area of the unit filters such a multitude of drops each minute that any desired flow rate may be obtained without increasing the filter to unwieldly size.

The metal-edge element achieves this same result through the operation of a different principle. This filter is constructed by winding a metal ribbon around a metal cage or center. Depending upon the purpose for which the filter is designed, this metal may be of brass, copper, stainless steel, monel metal, etc. The ribbon is wedge-shaped. It is wound with the flat surface of the wedge on the outside so that the finished element looks almost like a solid piece of metal. Strands of ribbon are separated, however, by tiny uprights at intervals along the upper edge of the ribbon. These spaces form an almost continuous slot, the sharp edges of which shear off all contamination larger in size than the width of the slot. Since this slot may be designed as fine as 0.0005-inch, provision is made for the finest desired degree of filtration.

All of these metal-edge filters have provision

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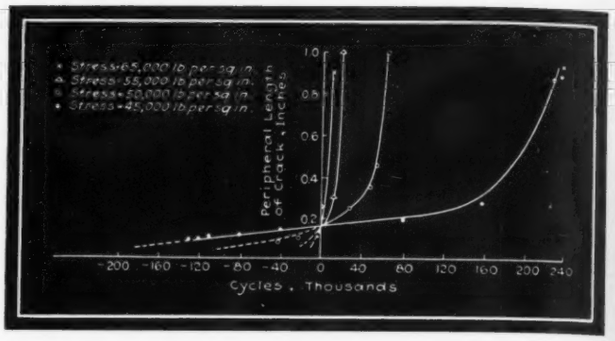


Fig. 1—Propagation of fatigue cracks in cold-rolled SAE 1020 steel with surfaces left as rolled

By A. V. de Forest

Guard Against Fatigue Failures Caused by Design

FATIGUE limits under standard conditions are quoted for many varieties of steel under varying conditions of heat-treatment. These figures represent the maximum load which a smooth specimen will endure without failure after a large number of repetitions of the same load, and the values arrived at are as nearly an accurate representation of a particular mechanical property of the metal as is, for example, its tensile strength, its hardness or its average elongation in a tensile test.

Those who have been particularly concerned with fatigue failures under working conditions, have found that the fatigue strength shown by such a test was not the only factor in determining the relative merit of different steels. Fatigue cracks in service are primarily located either by the various notches resulting from design, such as fillets, screw threads and oil holes, or resulting from defects of surface such as grinding marks, grooves coming from machining operations, decarburized surfaces, or the accidental bruising received in handling.

Occasionally more serious notches are found, caused by defects in the metal itself, such as seams, (particularly dangerous in helical springs) quenching cracks, grinding cracks, and forging bursts. The special difficulties encountered in welding are not considered here. The

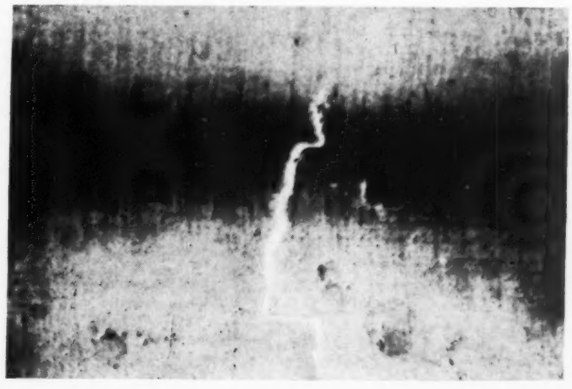


Fig. 2 — Magnetic method of testing clearly shows cracks in low carbon steel

TABLE 1

Rate of Growth of Fatigue Cracks

Stress, kips per sq. in.	*A*—Growth from start to crack 0.10 in. long X 1000 cycles				*B*—Total cycles X 1000				Ratio *A*/*B*				Rate of growth from 0.08 in. to 0.10 in., X 1000 cycles			
	CC*a*	CF*b*	LC*c*	CR*d*	CC	CF	LC	CR	CC	CF	LC	CR	CC	CF	LC	CR
65	...	..	..	40	...	..	..	59	..	..	..	0.68	..	..	..	..
55	..	..	..	130	..	..	..	157	..	..	..	0.83	..	..	..	..
50	90	217	288	680	131	265	339	768	0.69	0.82	0.85	0.88	7	10	8	20
45	166	482	748	1430	227	557	819	1783	0.73	0.87	0.92	0.81	12	12	15	50
40	436	1600	2720	....	541	1700	2820	....	0.78	0.94	0.96	....	20	17	22	..

a CC refers to coarse circumferential finish.
b CF refers to fine circumferential finish.
c LC refers to coarse longitudinal finish.
d CR refers to the bar finish as rolled.

sharpness of the notch under a grinding crack or quenching crack is probably of the same order of magnitude as in the fatigue crack itself.

In other words, the useful fatigue strength of a material is largely limited by its resistance to various forms of "stress-raisers" rather than by its endurance limit under test conditions.

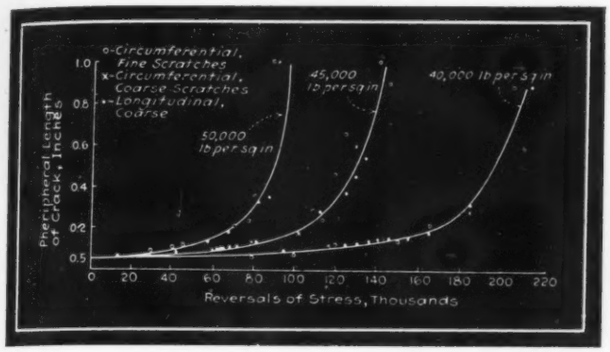

o-Circumferential, Fine Scratches
x-Circumferential, Coarse Scratches
•-Longitudinal, Coarse
45,000 lb per sq in
40,000 lb per sq in
50,000 lb per sq in
Peripheral Length of Crack, Inches
Reversals of Stress, Thousands

Fig. 3—Propagation of fatigue cracks from 0.05 inch to fracture for all surface conditions for annealed cold-rolled bars of SAE 1020 steel, five-eighths inch diameter

FATIGUE failures and their causes, given little consideration a short time ago, have been the subject of such intense study that today design limits can be reliably based on the findings. In this article, abstracted from a paper presented at a recent Mechanical Engineers meeting, the author, Massachusetts Institute of Technology, further clarifies the problem by differentiating between types of fatigue failures and pointing out how minute cracks can be discovered

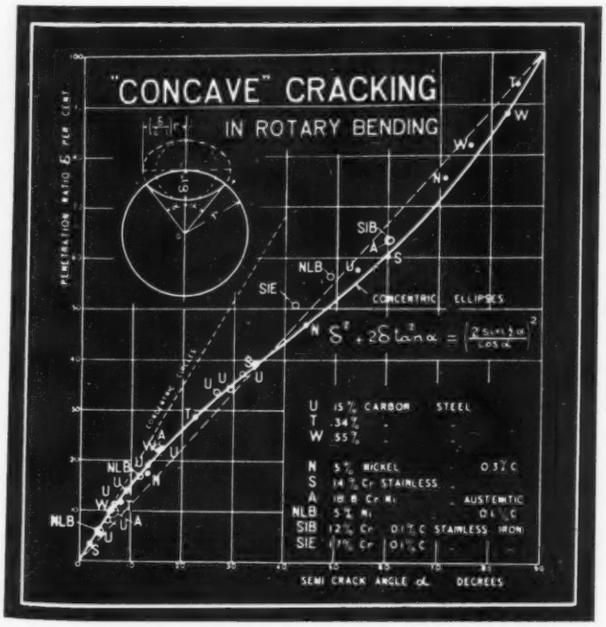

"CONCAVE" CRACKING
IN ROTARY BENDING
PENETRATION RATIO % PER CENT
SEMI CRACK ANGLE DEGREES
CONCENTRIC ELLIPSES
U 1.5% CARBON STEEL
T .34% "
W .55% "
N 3% NICKEL 0.3% C
S 14% Cr STAINLESS "
A 18-8 Cr-Ni " AUSTENITIC
NLB 5% Ni 0.1% C
SIB 12% Cr 0.1% C STAINLESS IRON
SIE 17% Cr 0.1% C

Fig. 4—Successive shapes assumed by a fatigue crack starting from a single surface origin

It appears that for engineering use a further fatigue figure of merit must be taken into consideration, namely, the resistance of the metal to the propagation of a crack due to a stress-raising condition. This property has come to be called notch sensitivity. Quite evidently the moment a true fatigue crack has started at the bottom of a notch, the crack itself constitutes the greatest stress-raiser and the sharpest of all possible notches. We then have three figures bearing on the fatigue strength of metals. First, the strength of the unnotched material, a figure now well known. Second, the strength under a finite mechanical notch. This figure is both a measure of the sharpness of the notch and of the true notch sensitivity of the metal. Third, the strength of the steel by virtue of which it resists the progress of the natural fatigue crack.

Two values bearing on sensitivity may require determination: (1) The maximum stress at which a fatigue crack will not propagate, and (2) the rate at which a given crack will propagate. It is probable that a fixed relation exists between these two values.

Reversals Required Are Important

The information we desire from tests is twofold. First, the stress and number of reversals required to start a fatigue crack under various notch conditions, from the plain polished specimen to the sharpest notch met with under engineering conditions. This figure is largely determined by surface rather than material. And second, the resistance of the material to the effect of a fatigue crack once it has been formed, a figure purely dependent on the metallurgical constitution of the metal and totally independent of the pre-existing surface. No novelty is claimed for this point of view. Bacon[1] has long emphasized the spread of fatigue cracks in his investigations. French[2] developed the "damage-line" method of determining the start of fatigue, and Moore[3] in the "overnight" test approaches the same principle. Many other thoughtful workers have the same distinction in mind.

The method here described is simply a somewhat more elaborate manner of studying the problem. Use has been made of the magnetic method for locating minute cracks by magnetizing steel specimens and applying finely divided iron particles, these particles usually suspended in a liquid medium. The following results are from a thesis by W. F. Magnuson.[4] Questions at

[1] "The Relation of Fatigue to Modern Engine Design," by R. A. MacGregor, W. S. Burn, and F. Bacon, *Transactions of the N. E. Coast Institution of Engineers and Shipbuilders*, vol. 51, 1935, pp. 161-228.

[2] "Fatigue and Hardening of Steel," by H. J. French, *Trans. A. S. S. T.*, vol. 21, 1933, p. 899.

[3] "An Overnight Test for Determining Endurance Limit," *Trans. A. S. T. M.*, vol. 33, 1933, part 2.

[4] Thesis of F. W. Magnuson, Massachusetts Institute of Technology, 1935.

sue were to determine whether, as seemed probable, the rate of growth of a fatigue crack was constant in a given material and independent of the number of cycles required to start a crack, and whether a different metallurgical condition of the same material would markedly change the rate of progress of a previously formed crack. To answer these questions a set of low-carbon cold-drawn specimens was tested. No attempt was made to determine absolute fatigue limits and consequently high values of stress were used. The specimens were in the form of $\frac{5}{8}$-inch diameter bars, 4 feet long, with a loaded length of 12 inches. At intervals during the test the bars were magnetized and inspected

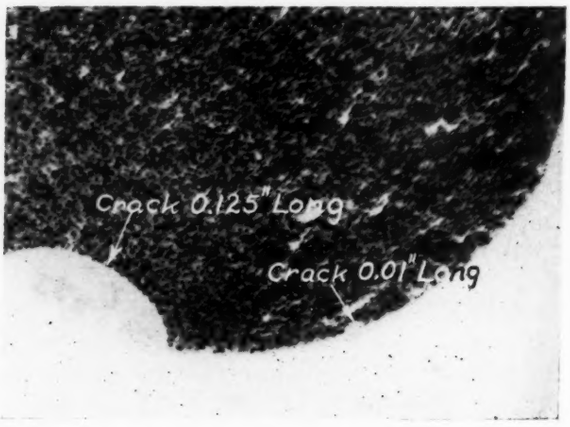


Fig. 5—Extremely small cracks as indicated are brought out by testing method

with finely divided iron oxide in a bath of kerosene.

At the higher loading figures a certain amount of heat was developed but this was not considered sufficiently serious to require control. The figures in TABLE I were derived from tests on annealed cold-rolled low-carbon steels bars with three different types of surface finish. One, a finish with coarse circumferential scratches from a bastard file; another, with fine circumferential scratches produced by polishing with number 0 emery paper; and a third, with coarse longitudinal scratches produced by axial rubbing with No. 73 coarse emery cloth. The bars were annealed in a 2-inch pipe and the finish removed all trace of scale. Conditions did not favor the formation of decarburized surfaces. A series of runs was also made on the cold-drawn bar without annealing. In this particular set of tests no attempt was made to locate the very earliest fatigue crack. The bars were run a length of time estimated to produce a crack of the order of 0.05-0.10 inch of circumferential length. This length was measured with an eye piece micrometer and low-power binocular microscope. The rate of progress of the crack was measured in the same manner. In *Fig.* 1 is shown a characteristic curve of the rate of progress of the crack plotted against number of revolutions. In this plot the measurements are started at 0.15 inch of length.

In TABLE I is tabulated the number of cycles at which the crack reached a length of 0.10 inch. It is here very evident that in each case the expected relation between surface condition and start of the crack was found. Under the heading, "Rate of Growth" is given the number of cycles under different loads required to cause the growth of the crack from a length of 0.08-inch to a length of 0.10 inch. *Fig.* 3 indicates that the rate of growth of cracks in bars with different surfaces is dependent only on stress, and the average rate-of-growth figure for the different bars may be averaged. It is quite evident from TABLE I that the rate of growth in the cold-rolled bar is from one-half to one-quarter as rapid as in the annealed condition. It is to be expected, but has not been proved, that the load required to cause a crack to grow in the cold-rolled material is higher than in the case of the annealed metal.

Possibilities of Method Shown

Other specimens were prepared to indicate the possibilities of the magnetic inspection method. Bars of annealed cold-drawn low-carbon steel and of centerless ground high-carbon drill rod were subjected to overload conditions. Fatigue cracks started in great numbers. These are shown in *Fig.* 2. It was found characteristic of the cold-drawn material that the cracks were not sharply located by the surface finish but appeared to follow irregularities closely related to grain boundaries. In the high-carbon bars the cracks are located absolutely accurately by the very fine circumferential grinding marks. These fatigue-cracked bars had been heated by the heavy application of load to a temper-color temperature so that the section through a crack would indicate clearly its extent by the color of the fracture; a method described and used with great success by Professor Bacon. The bars were then cooled by immersion in liquid air and broken in small pieces under a hammer. *Fig.* 5 shows the appearance of different size fatigue cracks under these conditions.

It was found quite possible to pick out the most minute cracks that could be seen at 50 magnifications. The shape of the fracture appears to follow the lines described by Professor Bacon whose latest collected results for the successive shapes assumed by a fatigue crack starting from a single surface origin on a plain polished rotating-beam specimen are reproduced with his permission in *Fig.* 4. This shape is extremely regular and enables an estimate to be made of the depth of the crack from the length intersecting the surface of the bar.

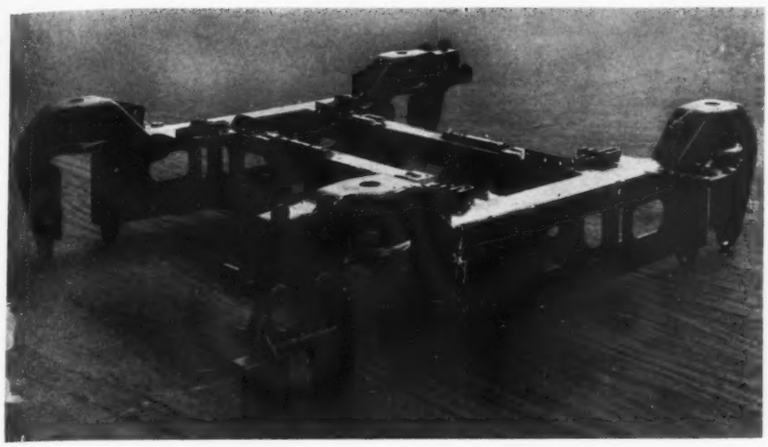


Fig. 1—Steel trucks, fabricated by welding, show combination of rolled shapes and alloy steel castings

Welded Shapes, Alloy Castings Reduce Weight

MODERNIZATION of transportation equipment has been pushed to commercial practicability in the last division of this field, subway-elevated cars, with the ordering of twenty-five five-car articulated trains by B. M. T. Lines of New York, following the success of two experimental units. In considering the type of truck frame, bolster and spring plank for these units, a number of designs were studied with particular attention being paid to weight saving. The 4000 pound saving possible through welded design was obviously highly desirable, especially from the standpoint of power saving in train operation, reduced wear and maintenance on wheels, track and other elements.

Due to the greater quantity of duplicate units involved compared to the original experimental train, an entirely different design viewpoint was necessary, from the production *(Concluded on Page 71)*

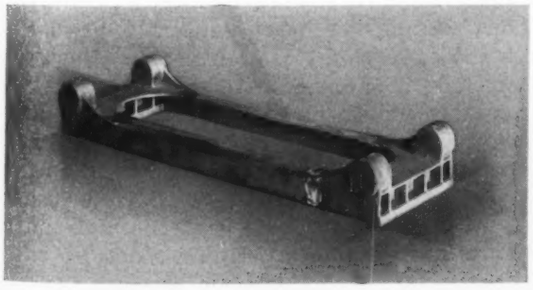


Fig. 2—Welded steel spring planks give ample strength with considerably reduced weight

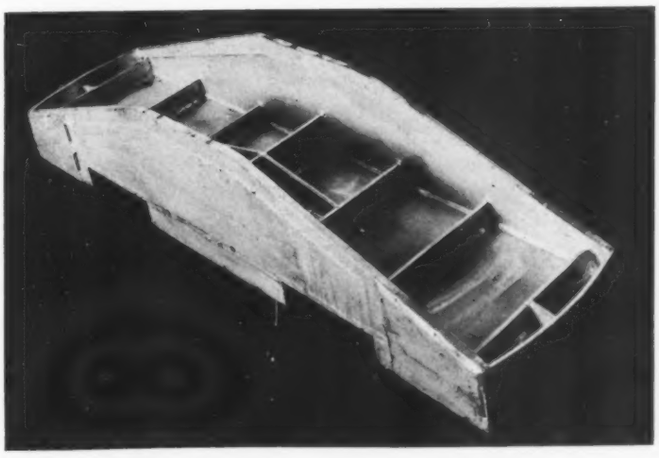


Fig. 3—Cromansil steel, weighing 340 pounds before machining, is employed in this bolster

How to Compare Load Ratings of Antifriction Bearings

By J. L. Haynes

ENGINEERS have become quite familiar with the fact that the load ratings for a range of bearing sizes as published by one bearing manufacturer are not directly comparable with the published data of another bearing company, even where the bearings are interchangeable, unless the *average hours of life* used as basis is the same for both. The purpose of this article is to explain a few basic factors concerning bearing life expectancy and tests, which are frequently under discussion by designers specifying antifriction bearings. We shall omit almost entirely the consideration of familiar engineering data which is readily available in the catalogs published by the leading manufacturers of ball and roller bearings.

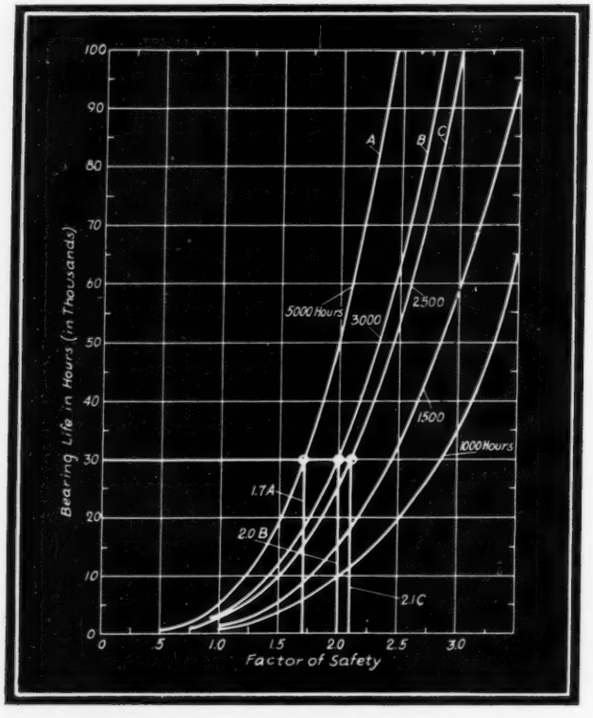


Fig. 1—Curves based on the average hours of life of bearings permit comparisons of ratings

If it is desired to compare two catalogs with different life bases it is customary to correct the figures of one before comparison with another by applying the rule that: Hours life is inversely proportional to the bearing load raised to the ten-thirds power. In other words construct a curve having the equation $YX^{10/3}$, and when $X=$ unity loading assign such a value to Y as will correspond to the standard number of hours used as a basis of bearing ratings by a particular manufacturer, and you will have a handy curve by which to determine the probable bearing life of any bearing of this make for which the load has been calculated in a given machine.

For convenience, we have constructed a series of curves shown in *Fig.* 1 to facilitate the accurate calculation of probable bearing life according to several common bases used by prominent manufacturers. Each of these curves shows the rate of change of bearing life as influenced by the factor of safety or perhaps a better name for the horizontal axis would be ratio of catalog rating to bearing load.

The five curves shown have been plotted to correspond with the 5000 hours, 3000 hours life, etc., respectively, as noted on the chart.

CONSIDERABLE uncertainty is encountered when an engineer compares the relative capacities of antifriction bearings where these capacities are not based upon similar data. In this article the author, of the Western sales division of Hyatt Roller Bearing Co., shows how these comparisons can be made and outlines how capacities for the bearings are determined

Some of the bearing manufacturers use the different basic life curves shown in *Fig.* 1 and in certain cases the same company issues two sets of catalog ratings for its bearings to suit the practice of different industries. For instance, one catalog, intended only for the use of the automotive industry, uses 1500 hours as a basis for bearing life while the same line of bearings would be shown in a "general industrial" catalog to have load ratings based upon 5000 hours.

From the curves in *Fig.* 1 it is evident that the ratings at 1500 hours would be 1.45 times the ratings at 5000 hours or conversely the 5000 hour rating is equal to 0.69 times the 1500 hour rating.

Compares Different Ratings

The real value of a chart like *Fig.* 1 is best appreciated when working out a design which may require a number of antifriction bearings of different manufacture with different basic load-life ratings. To illustrate by means of a simple example, let us assume that a machine requires three types of bearings, *A*, *B* and *C* which appear to suit the types of service for three different parts of a machine. These three bearings are manufactured by different companies using respectively 5000, 3000 and 2500 hours as their life ratings.

We will assume that the machine being designed is for a class of service where 30,000 hours bearing life has been specified as desirable. From *Fig.* 1, we see that the horizontal line through 30,000 hours intercepts the three curves in question so as to require a factor of safety of 1.7 for bearing *A*, 2.0 for bearing *B*, and 2.1 for bearing *C*.

Thus in order to pick the correct size of bearing from each of the three catalogs for *A*, *B* and *C* so as to give them all 30,000 hours average life, the procedure is to multiply the load that has been calculated for each bearing by the corresponding factor of safety and then select the bearing of the nearest size to correspond with this product.

The results obtained through the foregoing method will be as nearly correct as the state of the art enables us to work, and on a comparative basis the designer is at least dealing equitably with the competitive phases of the problem.

Determining Load Ratings

The general subject of properly choosing bearing sizes for any new set of conditions is so far from being an exact science that an explanation of the methods of determining bearing load ratings may help give the designing engineer a clearer view of antifriction bearing performance in general.

In the preparation of data to use in catalog ratings, there are some points seldom touched upon which it may be of advantage to discuss.

The art of manufacturing bearings has been, and is evolving so rapidly that a test of a series of bearings under loads corresponding to the hours life desired in general industrial service is quite out of the question, as before such a long-time test could be completed the chances are that the data would be obsolete and therefore useless due to improvements made in the bearings or in the methods of manufacture.

Thus to save time, as well as money for labor

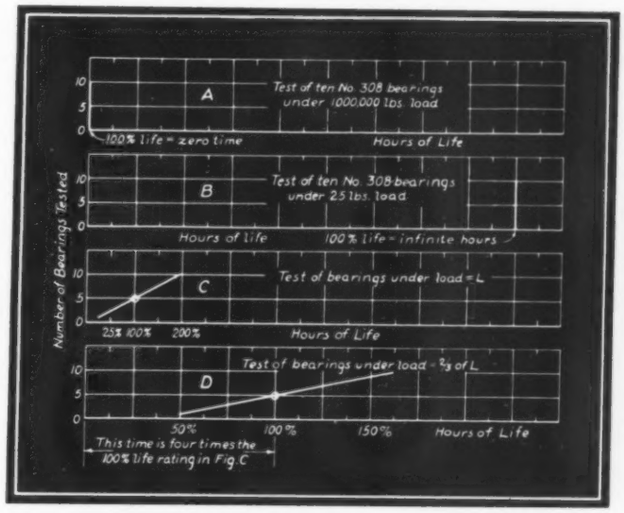

A
Test of ten No. 308 bearings under 1000,000 lbs. load
100% life = zero time
Hours of Life
B
Test of ten No. 308 bearings under 25 lbs. load
Hours of Life
100% life = infinite hours
C
Test of bearings under load = L
25% 100% 200%
Hours of Life
D
Test of bearings under load = ⅔ of L
50% 100% 150%
Hours of Life
This time is four times the 100% life rating in Fig. C
Number of Bearings Tested
10
5
0

Fig. 2—Varying loadings will give bearing curves between instant failure and infinite life as shown

and cost of laboratory space, bearing manufacturers follow the practice of making short-life tests under heavy loads so as to obtain comparative data for different bearings without too long delay.

In making overload tests of a considerable number of identical bearings, it is always a little surprising to find that there is a very great spread in the life before failure of the poorest and the best bearing of the group. This fact has caused undue alarm to some bearing users who get the impression that trouble is imminent because the tables of bearing ratings in a catalog were worked up from a series of bearing tests in which average life, expressed as 100 per cent, was obtained from a group of bearings, the worst of which failed in as little time as 25 per cent of the average life and the best one ran for perhaps 200 or 300 per cent of average life.

In other words, some engineers erroneously conclude that when a line of machines has been sold with the bearing life figured for an average of 10,000 hours, there is certain to be one or more of the units which will have only 2500 hours life before bearing replacement becomes necessary.

We shall try to show why the foregoing conclusion is incorrect. Let us assume that we have

ten standard single row radial roller bearings of the 308 size, which one of the leading manufacturers lists in the catalog as having 3080 pounds load rating at 500 RPM based on 5000 hours average life.

If it were possible to test all ten of these bearings with an overload of a million pounds, they would all fail the instant the tests started so there would be absolutely uniform performance among all ten of the bearings. *Fig. 2A* shows in graph form the results of this absurd theoretical test. The vertical line coincident with the Y axis is the performance curve of the ten bearings and the fact that the curve has no slope is ideal from the viewpoint of indicating consistent performance.

A very different theoretical test might have been run with these bearings as shown by *Fig. 2B*. If the ten bearings of the 308 size were to be run under the extremely light loads of 25 pounds it would take so many years to wear them out under clean laboratory conditions that the life may be considered infinite as compared to any commercial requirements. Therefore, a vertical line at the right of this figure represents the performance curve of the ten bearings under absurdly light loading.

Possible Life Varies Widely

Between the two extreme conditions illustrated by *A* and *B* in *Fig. 2*, there may be a vast number of tests considered with loads that correspond to average life ratings which might vary from a few hours to several thousand hours. It is rather surprising at first glance to note from *Fig. 1* that with a variation of bearing load of 490 per cent from 0.5 "factor of safety" to 2.45, the life will vary from 500 to 100,000 hours, corresponding to 20,000 per cent.

We cite this to show that in making overload tests in the laboratory, it does not take a great variation in the imposed load to make a very great difference in life and it therefore seems quite natural that there should be a considerable variation in performance among a group of practically identical test bearings that are run as nearly as possible under the same set of conditions.

In *Fig. 2*, *C* and *D* have been constructed to illustrate the approximate relative bearing performance curves that would result if the ten 308 bearings had been tested under loads that vary in the ratio of three to two.

Thus in *Fig. 2C*, we regard the test load as unity and the average life as unity. In *Fig. 2D* the load is decreased to two-thirds as much as *C* and the average bearing life is therefore four times as long, as determined from *Fig. 1*.

In both *C* and *D*, *Fig. 2*, the performance curves are shown as straight lines and they represent the loci of points indicating the time when each of the ten bearings failed. The average life of the ten bearings in each figure is shown to be that corresponding to the time elapsed when the fifth bearing failed.

It is generally agreed that a series of catalog load ratings based upon tests in which the foregoing method is used will be more conservative than figures based on the total bearing hours run by all ten bearings. In other words the use of weighted averages, while technically correct, will show a higher average figure for the group of bearings tested than that corresponding to the time required to break down one-half of the bearings under test because you take no advantage of the fact that the second half of the group of bearings, which have not yet failed, are in each instance better than any of the ones included in the first half to fail.

Reduces Extreme Variation

In Fig. *2C* the time elapsed when the first bearing failed is shown to be 25 per cent of the average life while for the lighter loaded test in *Fig. 2D* the first bearing does not fail until 50 per cent of the average life has elapsed. The last bearing to fail in *Fig. 2C* is shown to have a life of about 190 per cent of the average while the tenth or last one in *Fig. 2D* had a life of only 160 per cent of the average. That is to say, the per cent of extreme variation in bearing life, above and below the average life, tends to be reduced as we operate with lighter loading such as suitable for long life types of equipment.

It appears, therefore, that as the test indicated in *Fig. 2C* may be considered to be repeated with a heavier and heavier load the performance line acquires a steeper and steeper slope and the entire line moves to the left approaching the condition of the absurd test illustrated in *Fig. 2A*. In like manner, if the test load used for *Fig. 2D* had been made progressively lighter and the tests repeated under such loads, the performance line would have become steeper and steeper in slope and it would move to the right until approaching as a limit a vertical line like the one for *B*.

All Units Near the Average

The purpose of the preceding discussion is to try to make it clear why the engineer who is designing a piece of industrial equipment using antifriction bearings, for service where many years of reliable operation is demanded, does not need to worry about the bearing performance for some few units being very much below the average for a given group.

Although it is obviously impossible to suppose that the life expectancy should be substantially the same for any group of similar machines with respect to bearings, gears, or any other parts, it is nevertheless a fact that antifriction bearing performance can be made just as consistently reliable as any of the other machine parts for any class of equipment.

Dynamic Load Governs Gear Steel Choice

By V. M. Faires

Professor of Mechanical Engineering, Agricultural and Mechanical College of Texas

WHEN determining the necessary properties of steels for specific gears, the design load should be taken as the dynamic load on the gear tooth. This dynamic load, as outlined in the recommendations of the American Gear Manufacturers association, is equal to the transmitted load plus an increment load. The increment load is the force resulting from a momentary acceleration of the gears which in turn is largely the result of inaccuracies in the outline and spacing of the teeth, in the deflection of the teeth under load, and in the unbalance of the rotating gears. The formula for computing the dynamic load, as given in the standard practice instructions, is based upon the assumption of gears of average weight, which therefore produce accelerating forces of average values. Dynamic load, since it accounts for forces resulting from accelerations as well as the force applied by virtue of the transmitted power and speed, is an estimation of the total maximum load that may act on the tooth.

The Lewis equation for the strength of gear teeth is used, as of old, to determine the load the tooth may carry, except that the design stress instead of being some "safe" stress, in the old fashioned meaning of the words, is a *limiting* stress. If the stress induced in the tooth by the dynamic load is greater than this limiting stress, failure is expected to occur. This limiting stress was at first considered to be the stress at the elastic limit. However, in view of the na-

TABLE I

Effect of Heat Treatment on Properties of Steels

Steel SAE No.	Tempering Temp.	Tensile Strength	Brinell Number	Per Cent Elongation in 2 in.
1035	600	118,000	240	10
	1300	85,000	170	28
1045	600	150,000	317	8
	900	130,000	260	16
	1300	97,000	196	26
2335	400	240,000	450	12
Nickel	800	170,000	340	17
Steel	1200	110,000	230	26
3145	400	252,000	490	8
Nickel-Chr.	800	193,000	378	13
Steel	1200	117,000	235	22
3250	400	280,000	528	7
Nickel-Chr.	800	205,000	405	12
Steel	1200	131,000	275	21
4640	500	250,000	480	10
Nickel-Moly.	800	181,000	390	14
Steel	1200	113,000	241	23
5150	800	222,000	461	9
Chr.-Steel	1300	120,000	235	22
6150	800	229,000	461	10
Vana. Steel	1300	119,000	235	23

TABLE II

Properties of Steel, as Rolled, Annealed, Normalized

SAE No.	Condition	Tensile Strength, psi.	Yield Point, psi.	Elong. Per Cent 2 in.	Brinell Number
1030	As rolled	82,000	51,000	26	163
	Annealed	75,000	47,000	31	149
	Normalized	80,000	53,000	27	156
1040	As rolled	92,000	56,000	23	187
	Annealed	85,000	52,000	28	167
	Normalized	90,000	59,000	24	179
1050	As rolled	102,000	60,000	20	207
	Annealed	95,000	57,000	25	187
	Normalized	100,000	64,000	18	197
2330	As rolled	100,000	71,000	25	197
	Annealed	91,000	63,000	29	179
	Normalized	100,000	70,000	26	197
2340	As rolled	110,000	77,000	21	217
	Annealed	100,000	66,000	25	197
	Normalized	110,000	76,000	22	217
2350	As rolled	120,000	84,000	18	235
	Annealed	109,000	70,000	22	212
	Normalized	120,000	82,000	19	235
3130	As rolled	95,000	73,000	26	197
	Annealed	88,000	66,000	30	192
	Normalized	96,000	72,000	25	197
3140	As rolled	109,000	78,000	22	223
	Annealed	99,000	69,000	26	202
	Normalized	110,000	77,000	20	229
4630	As rolled	102,000	78,000	23	207
	Annealed	90,000	70,000	27	179
	Normalized	105,000	77,000	24	212
4640	As rolled	116,000	93,000	18	235
	Annealed	99,000	80,000	22	197
	Normalized	120,000	97,000	19	241
4650	As rolled	130,000	108,000	14	255
	Annealed	108,000	90,000	18	217
	Normalized	135,000	115,000	15	262
Cast	As cast	.....	37,000	....	160
Steel	Annealed	.....	41,500	....	145
(1030)	Heat treated .	.....	50–97,000	....	155–250

ture of the load which is repeatedly applied, the "AGMA Practice of Computing Load-Carrying Ability of Metal Spur Gears" (May 1934) now recommends the use of the flexural fatigue limit in determining the strength of gear teeth. Although the tooth is subjected to a unidirectionally repeated stress rather than a reversed stress, the AGMA Practice recommends stresses which are approximately equal to the fatigue limit of the material in reversed bending.

Outlines Fatigue Limits

According to Moore and Kommers, *The Fatigue of Metals,* the fatigue limit for a range of stress from zero to S_{max} is 50 per cent higher than the fatigue limit for a range of stress from $-S_{max}$ to $+S_{max}$. However, the fatigue limit for unidirectionally repeated loads would appear to be too high to be safe for use on gear teeth (at least, without a generous margin of safety) possibly because of the concentration of stress at the fillet. Moreover, the indiscriminate use of a flat 50 per cent factor may sometimes result in a stress exceeding the elastic limit, whereas the recommendation is contingent upon elastic action.

TABLE III

Properties of the Core of Case-Hardened Steels

Steel SAE No.	Tempering Temp.	Core Properties Tensile Strength	Brinell Number
1020	1525	90,000	180
	1625	105,000	210
2115	1600	155,000	320
3115	1400	130,000	260
	1475	180,000	360
4615	1425	115,000	220
	1525	150,000	300
2315	1375	95,000	200
	1425	130,000	290
	1475	180,000	390
2512	1350	115,000	210
	1400	150,000	290
	1460	200,000	390

High Safety Factor Advisable

Prof. Earle Buckingham has found that the use of the endurance strength in reversed bending is on the safe side, far enough on the safe side that the margin of safety need be only 1 for average operating conditions. For unusually severe conditions, a margin of safety greater than 1 is advisable. The margin of safety is here considered as

$$\frac{\textit{Strength of tooth from Lewis equation}}{\textit{Dynamic load}}$$

In the following discussion, therefore, it is assumed that the design stress for finding the limiting strength of a gear tooth will be taken as the stress at the endurance limit in reversed bending.

In order to estimate the wearing qualities of gear teeth in accordance with the procedure of the AGMA, we need to know the brinell hardness (or the equivalent brinell number) of the *surface* of the tooth. If the wear equation should give a value of the load less than the dynamic load, we should expect the gears to have a short life, provided the service is continuous.

Now the data needed for these various computations is generally available in the literature of the industry. There are needed, however, brief summaries in handy reference form, and the object of the following is the presentation of such summaries.

Approximate Relations Given

For steel, there are certain approximate relations between the ultimate strength, the endurance limit, and the brinell hardness number. Up to a brinell number of about 400, and less accurately for higher numbers, the ultimate strength is roughly 500 times the brinell number; that is,

$$s_{ult} = (500)\ (\textit{brinell number})$$

If this approximation is used on casehardened teeth, safe practice suggests the use of the *core* hardness in estimating the strength. For forged steels most experiments point to an endurance limit in reversed bending of about one-half the ultimate strength. Therefore, we may say (approximately)

$$\textit{Endurance limit} = (250)\ (\textit{brinell number})$$

Although it is evident that in careful design more accurately determined properties of the material should be obtained if possible, these estimations may serve a useful purpose where unusual discrimination is unnecessary and uneconomical of time. Moreover, the time required for fatigue tests makes it impracticable to find by experiment the endurance limit corresponding to all the various combinations of material and heat treatment. The designer should be warned that the fatigue ratio of (endurance limit)/(ultimate strength) falls off to values below 50 per cent, when the strength is above 200,000 pounds per square inch. On the other hand, some low-carbon steels, for example, low carbon nickel-steel, have fatigue ratios greater than 50 per cent.

Treatment Is Necessary

To obtain the maximum wear from gear teeth, it is necessary to heat treat them. Casehardening (by carburizing) produces surfaces with an equivalent brinell hardness of from 550 to 650 and higher. Low carbon steels and al-

loys are suitable for casehardening. Case-hardened nickel steel (2515) and molybdenum steels (4615 and 4620) may have a *core* hardness of 300 to 390 brinell. Carbon steel (1020) may have a core hardness of about 200 brinell. Some properties of the core of casehardened steels are given in TABLE III. All values are for water-quenched steel. If the steel is oil quenched, the strength and brinell number will each be slightly lower in most cases.

Plain and alloy steels of a carbon content of 0.40 to 0.50 per cent may be surface hardened by cyaniding. Such materials as SAE 3145, 4640, 5145, 6150 will have a case hardness equivalent to 480 to 600 brinell after cyaniding, and a core hardness of 440 to 570 brinell.

Simple Treatment Satisfactory

Gear teeth with very good wearing qualities may be obtained from the medium carbon steels by a simple hardening and tempering heat treatment. TABLE I is a convenient, brief summary of certain significant properties of several steels. It is advantageous to note that the curves of brinell numbers plotted against the tempering temperature and of ultimate strength plotted against the tempering temperature are often nearly a straight line. Hence, for either ultimate strength or brinell number there is likely to be little error in making a straight-line interpolation in this table whenever the values at some other tempering temperature are desired. In making the interpolation, observe that the maximum strength corresponds to the *lowest* tempering temperature.

In those instances where the teeth are not to be casehardened or cyanided, the values in TABLE II will be needed.

Appendix

Equations referred to are as follows:
Limiting strength of tooth

$$F_t = \frac{sbY}{P_d}$$

Dynamic load,

$$F_D = \frac{0.05v_m(bC+F)}{0.05v_m+(bC+F)^{1/2}} + F$$

Limiting wear load,

$$F_W = D_p b K Q$$

where

s = endurance strength of core in reversed bending
b = face of the gear, inches
Y = Lewis' factor based on diametrical pitch $= \pi y$, where y is the value based on circular pitch
P_d = diametrical pitch
v_m = pitch-line speed, foot per minute
C = factor to account for errors in tooth profile
F = transmitted load $= 33{,}000\ h_p/v_m$
D_p = diameter of pinion, inches
K = wear factor, a function of the surface brinell number for steels
$Q = 2D_g/(D_p+D_g)$, where D_g = diameter of gear, inches

Exposition Features Metals and Improved Lighting

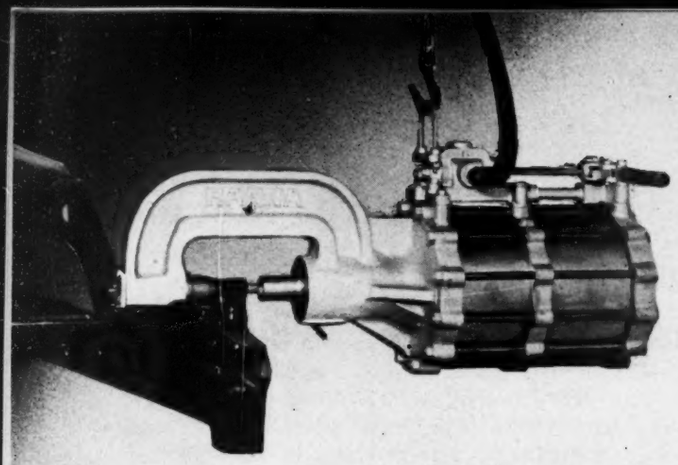
GREATEST interest from an industrial standpoint in the Great Lakes exposition which opened at Cleveland June 27 centers in a large underground exhibition hall where a central towering exhibit of various steps in the mining of ore and making of iron and steel are depicted, the machinery and materials exhibits, the 228 by 541-foot automotive building which houses exhibits of automobile builders and automotive parts producers, the 180 by 540-foot hall of progress in which are located displays of public utility interests, federal government and others,

Trough reflectors aid in providing maximum illumination with walk pylons on exposition grounds

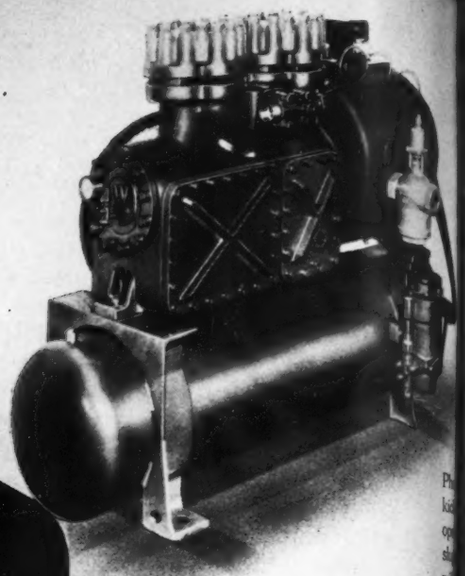
and the several exhibits showing the progress in the porcelain enameling of sheets.

Spectacularly setting off these exhibits and the many other cultural and recreational displays is an unusual plan of lighting which gives a greater intensity of light than previous expositions. In each portion of the grounds a different type of lighting is utilized. The Horticultural Gardens are lighted with Westinghouse mercury lighting units which show the foliage of trees and shrubs in their natural colors, the light rays having the effect of daylight, and "shorty" mushroom lights a foot high to illuminate paths, rock gardens and flower beds.

Lighting of walk pylons such as those shown in the accompanying illustration is given a uniform tone by the use of trough reflectors. An unusual type of lighting standard for general illumination has a 500-watt lamp in an opal glass shade covered with Micarta tops of red, green, blue and yellow. Near the lake side entrance to the exposition is a lighthouse 30 feet high, the top of which contains the most powerful rotating beacon in the world. The beam from this beacon is 14 million candlepower, seven times that of the famed Rogers-Post beacon in New York.

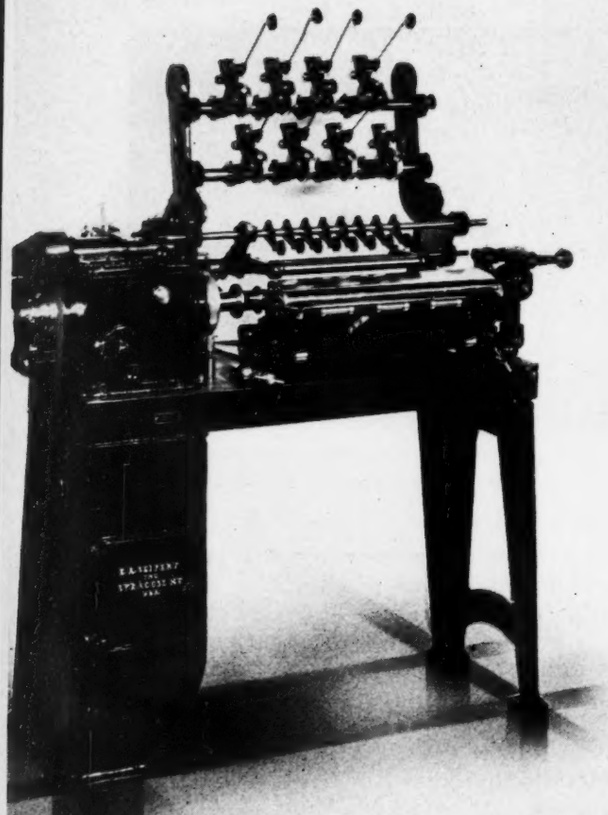


Last portion of the piston travel on this Hanna portable press, above, is cushioned by methods individually designed to suit particular applications. Power unit consists of a piston and cylinder assembly direct acting on the live die.



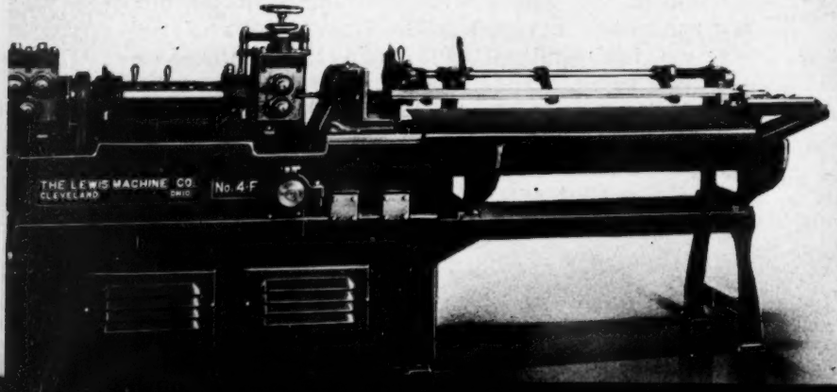
Designed in New ac

A Pictorial Presen[tation] of Rece[nt] from the S[tudio] of [Henry Dreyfuss]

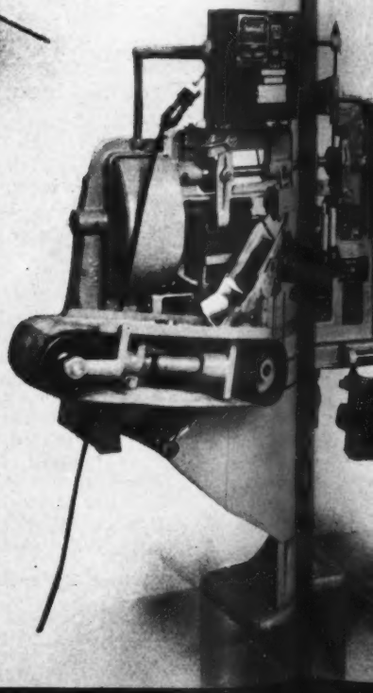


In order to keep the light and accurately machined housing of Seifert coil winding machine, above, in alignment, the base rests on a three-point support. Each tooth of the driving member is slidably mounted so that teeth which do not mesh are pressed back and the one which meshes engages without slippage.

Conventional stamper arm is replaced by a gear controlled roller platen mounted between two rigid stationary arms on new Addressograph, left. This platen rotates over the portion of the metal typing unit to be printed. A gear reduction and universal motor are concealed within the attractive one-piece base, designed compactly along modern lines.

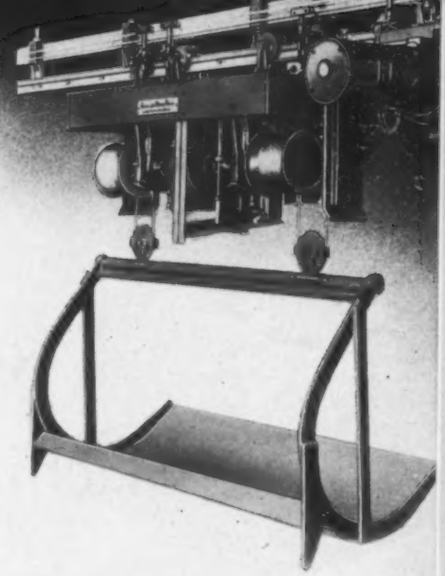


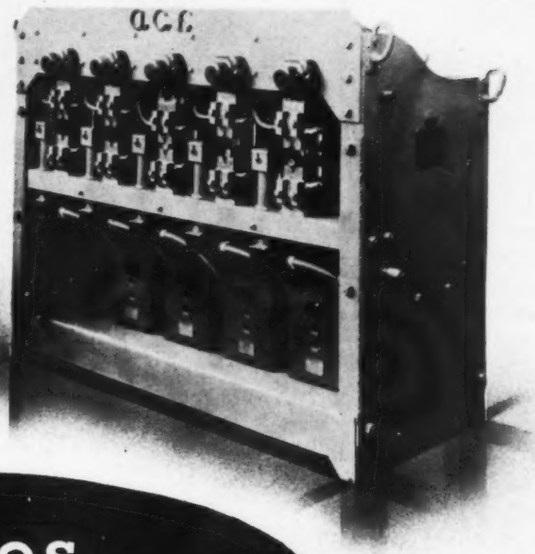
Cut-off drive mechanism including the cut-off cam and traveling head drive crank are sealed in the machine bed and run in oil on Lewis automatic wire straightening and cutting machine, left. A three-speed feed and two-speed flywheel transmission makes possible a wide variety of work.



ly and hermetically sealed, the the Westinghouse air condition- ensing unit encloses the motor s all other parts so that no ut is required. Cooling of the effected by means of a water round the motor, within its through which water constantly

From a central control panel which can be set for forty operating cycles, this new American conveying machine, right, is automatically dispatched to one of two loading tables where it picks up a roll of cloth, raises it and travels to a warehouse to deposit the load. It returns automatically.



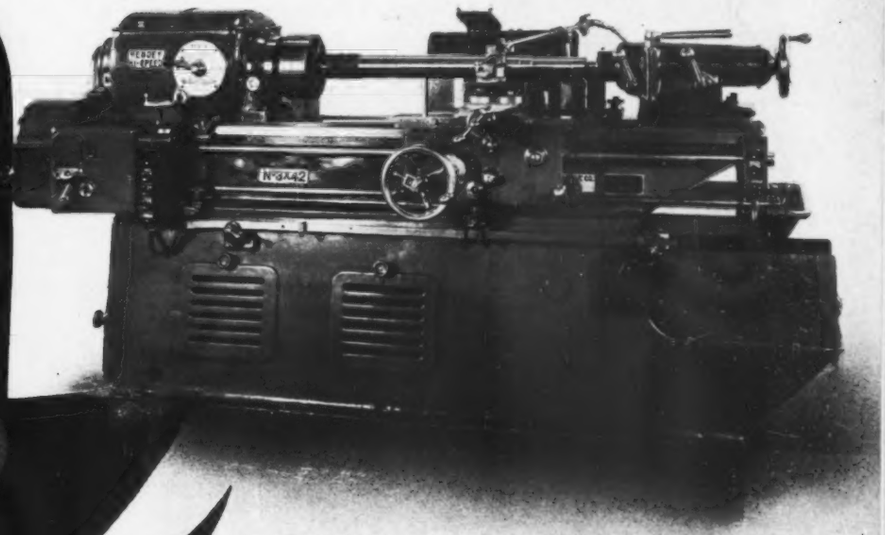


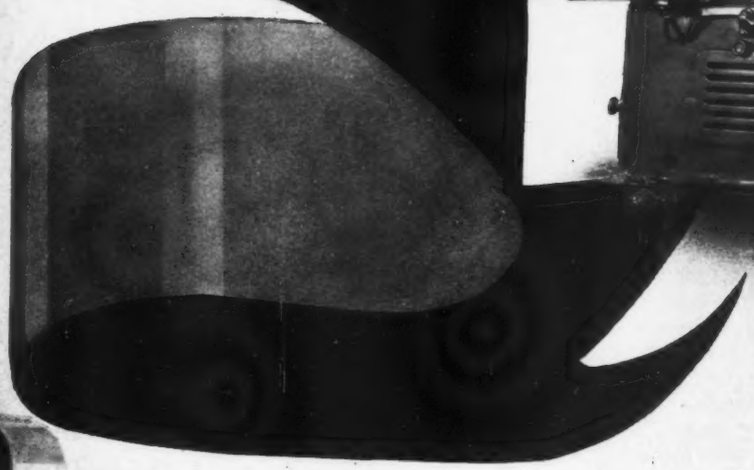
cells and automatic device control all Berwick electric metal ght, so that the pieces oved at the exact at which the photo- set.

gn eatures
ew achines

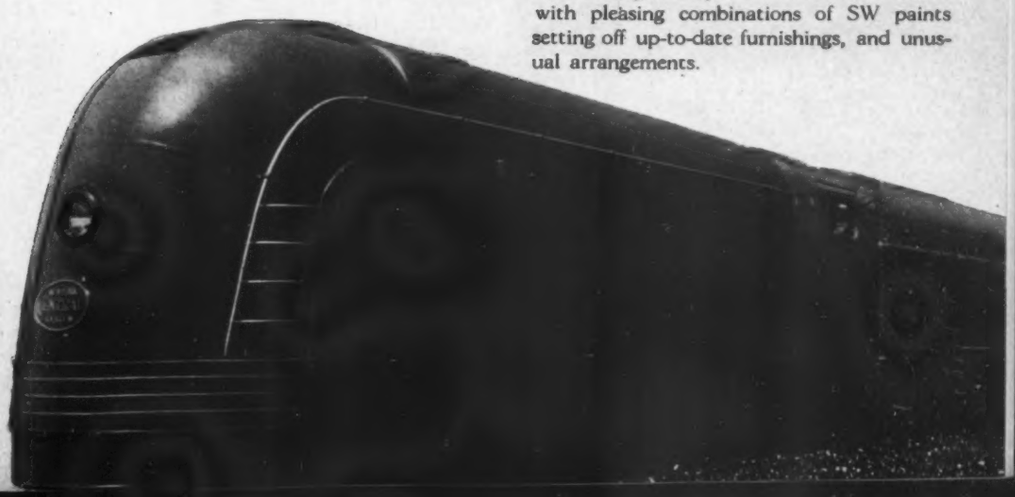
Present Recent Machinery the S nt of Design.

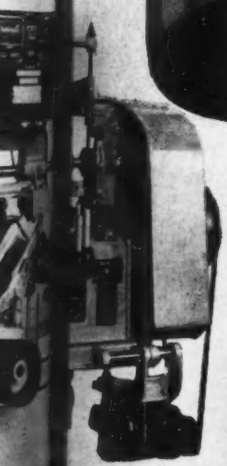
Power for Hendey step-turning lathe is supplied by a ND infinitely variable speed unit coupled to a constant speed electric motor. A multi-tooth positive clutch drives the spindle through multiple keys, hobbed from the solid.





Seven light-weight steel cars are drawn by this streamlined modern locomotive of the New York Central. The design of the interior of these cars, by Henry Dreyfuss, is an outstanding example of modern treatment with pleasing combinations of SW paints setting off up-to-date furnishings, and unusual arrangements.





Cartridge type heating units controlled from a switchboard confined within the metal cabinet shown on top of the machine, heat the sealing jaws of Stokes closing and sealing machine, left. Drive is by belt from a motor mounted on a swinging bracket.

New Machines Indicate Design Trends

Fabrication of parts by the die casting process has progressed to such an extent that there are few machines that would not be benefitted by the use of these improved die castings. Any opinion formed just a few years ago on the adaptability of die castings to any machine is now obsolete. The process has been considerably improved. Alloys of zinc, aluminum, brass and magnesium for die castings have been standardized and further perfected. Now designers can obtain die castings of gray iron which completes the range of materials needed for a great majority of machine parts.

Machines recently announced in addition to those on the preceding two pages include the following, arranged by fields of application:

Air Conditioning

Portable Unit, Continental Motors Corp., Detroit.

Direct Fired Furnace Units, Electrol Inc., Clifton, N. J.

Chemical

Collodal Mixer, Colloid Equipment Co., New York.

Domestic

Gas Electric Power Plant, Pioneer Gen-E-Motor Co., Chicago.

Washing Machines, Automatic Washer Co., Newton, Ia.

Water System, Trupar Inc., Dayton, O.

Portable Power and Light Plant, Kato Engineering Co., Mankato, Minn.

Foundry

Core Maker, Harry W. Dietert Co., Detroit.

Industrial

Hydro-Electric Generator, Stanley & Patterson Inc., New York.

Melting Furnace, Monarch Engineering & Mfg. Co., Baltimore, Md.

Gasoline Engine Tractor, Towmotor Inc., Cleveland.

Diesel Engine, Buda Co., Harvey, Ill.

Electric Drill, Stanley Rule & Level Works, New Britain, Conn.

Electric Marker, Ideal Commutator Dresser Co., Sycamore, Ill.

Degreasing Machine, Detroit Rex Products Co., Detroit.

Metalworking

Tank Forming Machine, Peck, Stow & Wilcox, Southington, Conn.

Electric Metal Heater, American Car & Foundry Co., New York.

Automatic Thread Grinding Machine, Jones & Lamson Machine Co., Springfield, Vt.

Culvert Curving Rolls, Geo. Whiting Co., Inc., Chicago.

Two-Column Vertical Speed Press, Oilgear Co., Milwaukee.

High Speed Universal Press, Flexo Machines, Chicago.

Hydraulic Die Spotting Press, Baldwin-Southwark Corp., Philadelphia.

Mining

Blade Mill, Allis-Chalmers Mfg. Co., Milwaukee.

Municipal

Street Sweeping Machine, W. E. Grace Co., Dallas, Texas.

Office

Cash Drawer Adding Machine, Allen Calculators Inc., New York.

Textile

Sueding Machine, R. L. Sjcstrom & Co., Boston.

Combination Legger & Footer, Robert Reiner Inc., Weehawken, N. J.

Padding Machine, Van Vlaanderen Machine Co., Harrison, N. J.

Rayon Skein Soaking and Tinting Machine, Johnson Engineering & Mfg. Co., Wilkes-Barre, Pa.

Welding

Spot Welding Machine, Acme Electric Welder, Huntington Park, Calif.

Flame Cutting Machine, Schoitz Tool, Gear & Machine Works, Waterloo, Ia.

MACHINE DESIGN

Utilization of Agricultural Products Means New Machinery

PRODUCTION of oil and plastics from the soybean and of fuel alcohol from corn and other agricultural products leaves no doubt as to the need for more new machinery, as well as to the mitigation to some extent of our national unemployment problem.

Credit, particularly from the employment standpoint, is due the Ford organization's efforts to utilize the products of agriculture, and their success to the extent of developing a need for about half-a-million bushels of soybeans for each million cars built. Furthermore, the impetus given the plastics industry and the equipment manufacturers by this Ford development can readily be foreseen.

Even greater stimulation might be forecast by the trend, particularly abroad, toward the use of alcohol for engine fuel. With the increasing demand for gasoline in this country and the comparatively limited supply available (it has been said that we have sufficient for only twelve years normal consumption) it is evident that the use of alcohol for extending this supply—and perhaps replacing it—is no wild dream.

Such changes call for new machines, new design thought, new openings. The designer's opportunity is here, just as it is in many other lines of equipment made necessary by the results of chemical and industrial research.

Design Will Benefit!

INTRODUCTION of new processes, materials and parts may be looked upon as easing the designer's load. Yet in some respects his problems become more complex, and the drain on his time more acute, as his choice of selection is widened.

Among the latest additions presenting opportunities in design is the welding process recently developed by Dr. Antonio Longoria which facilitates the welding of metals at temperatures far below those normally employed. Then there is the relatively older process of the pressure casting of iron, to which many machinery builders are giving serious consideration.

It is up to the engineer responsible for design to acquaint himself sufficiently with these newer processes as they develop to enable him to evaluate their merits in relation to methods previously used.

MEN of MACHINES

M. W. SMITH

CLOSELY identified with the design of alternating current machinery for the past ten years, M. W. Smith, recently appointed manager of engineering for Westinghouse Electric & Mfg. Co., has directed the design of some of the most advanced equipment. Among the recent designs brought out in his work as division engineer, the position held before his advancement, are Boulder Dam generators, Los Angeles hydrogen-cooled frequency changer, and Philadelphia 183,000 kva turbo-generator.

Following graduation from Texas A & M college in 1915, Mr. Smith joined Westinghouse as a student engineer. From that time until 1917 he worked on special problems under the guidance of the late B. G. Lamme, at which time he began his work in alternating current machinery.

• • •

E. S. SAWTELLE

SINCERE, intelligent co-operation has marked the participation of E. S. Sawtelle in the activities of the American Gear Manufacturers' association, an organization which he now heads as president. Every technical and business session of the gear makers has been featured by the studied comments of their new leader, also active in committee work.

Mr. Sawtelle is vice president and general manager of Tool Steel Gear & Pinion Co., Cincinnati. A native of Anaconda, Mont., he graduated from the University of Cincinnati in 1907. He soon after became connected with the Tool Steel company and assumed his present responsibility in 1931. Mr. Sawtelle also is president of Sawbrook Steel Castings Co., Cincinnati, and takes a leading part in civic affairs and in trade associations.

• • •

SAMUEL W. DUDLEY

AN OUTSTANDING authority in the application of braking mechanisms to railroad rolling stock equipment, and a man who has played an important part in the development of the air brake, Samuel W. Dudley, has been appointed dean of the Yale University School of Engineering. Professor Dudley has also done much original work with the braking equipment on electric rolling stock and the high speed streamlined trains which have attracted so much recent attention.

The new dean received his formal scientific training at Yale, where he graduated from the Sheffield Scientific school in 1900, and received the M. E. degree in 1903. He then joined the Westinghouse Air Brake Co. at Pittsburgh as an engineer, and soon was made local engineer in charge of the installation of electric

locomotives and multiple cars on the extensive electrification projects then being undertaken by the New York Central and the New Haven railroads. In 1914 he was appointed chief engineer of the company, and remained in that capacity until 1921, when he was called to Yale to one of the newly-established chairs on the Foundation provided by the will of Lord Strathcona and the Mount Royal of Canada, the Strathcona Professor of Mechanical Engineering.

♦ ♦ ♦

E. J. LEES has been appointed chief engineer of National Tool Co., Cleveland. Mr. Lees, who is an authority on the subject of gears and gear cutting, formerly was of the Lees-Bradner Co.

♦ ♦ ♦

ANKER K. ANTONSEN has resigned as chief designer at the Beloit, Wis. plant of Fairbanks, Morse & Co., and has moved to Skaneateles, N. Y.

♦ ♦ ♦

GEORGE H. FREERS has been made chief engineer of the package car division of Stutz Motor Car Co. A graduate of Rose Polytechnic institute, Mr. Freers has worked on engineering with several well-known automobile companies, including Marmon and Packard.

♦ ♦ ♦

F. J. KOEGLER has been elected president of Doehler Die Casting Co., Toledo, O., succeeding H. H. Doehler who has been appointed chairman of the board of directors, with headquarters in New York.

♦ ♦ ♦

A. E. DRISSNER, vice-president in charge of engineering, National Acme Co., Cleveland, is making a trip to Europe to study the machine tool situation.

♦ ♦ ♦

HARRY W. DIETERT has resigned as chief engineer of U. S. Radiator Corp., Detroit, to give more time to the sand, core and mold testing equipment manufactured by his own Harry W. Dietert Co. He will continue as a consultant for the Radiator corporation.

♦ ♦ ♦

C. W. BENNETT, president, American Sheet & Tin Plate Co., retired on June 1 after nearly thirty years of service with that company. Graduating in mechanical engineering from University of Wisconsin in 1892, Mr. Bennett worked for several years as machinist, draftsman and master mechanic before assuming executive duties.

♦ ♦ ♦

VANNEVAR BUSH, vice-president, Massachusetts Institute of Technology, has been elected chairman of the division of engineering and industrial research, National Research council.

♦ ♦ ♦

R. W. CHANDLER, chief engineer, Graton & Knight Co., Worcester, Mass., is spending some time in England organizing an association along the lines of the Power Transmission council.

♦ ♦ ♦

CARL LAGER, newly elected president of Morris Machine Works, Baldwinsville, N. Y., joined the company forty-six years ago as its chief engineer. He is an authority on design and application of rotary pumps.

♦ ♦ ♦

E. P. BURRELL, director of engineering, Warner & Swasey Co., Cleveland, has been given an honorary degree of Doctor of Engineering by Case School of Applied Science, in appreciation of his outstanding work as a designer of turret lathes and astronomical telescopes.

♦ ♦ ♦

JAMES B. FISHER, chief engineer of Waukesha Motor Co., Waukesha, Wis., has been elected vice-president of the company.

♦ ♦ ♦

H. O. HEM, consulting engineer, Toledo Scale Co., Toledo, O., has been given the honorary degree of Doctor of Science by the University of Toledo.

♦ ♦ ♦

C. E. SIMS has been appointed research metallurgist at Battelle Memorial institute, Columbus, O. Mr. Sims has been assistant director of research for American Steel Foundries, Indiana Harbor, Ind.

♦ ♦ ♦

GEORGE W. LEWIS, director of aeronautical research, National Advisory Committee for Aeronautics since 1924, has been awarded the Daniel Guggenheim medal for 1936. Mr. Lewis designed the first Roots blower type of supercharger for aircraft engines. He began work as an engineering instructor at Cornell university, where he graduated in 1908, and later was professor of engineering at Swarthmore College.

♦ ♦ ♦

C. N. MONTEITH, for nine years chief engineer of Boeing Aircraft Co., Seattle, has been elected executive vice president of that company. R. J. MINSHALL has been appointed chief engineer.

♦ ♦ ♦

GEORGE ENDICOTT, consulting engineer and formerly assistant to the vice president of Wickwire Spencer Steel Co., has joined the engineering staff of Morgan Construction Co., Worcester, Mass., builders of rolling mill equipment.

♦ ♦ ♦

CHARLES B. BOHN, president, Bohn Aluminum & Brass Corp., Detroit, is making a study in Europe of recent engineering developments.

♦ ♦ ♦

KENNETH W. MASSEY has been appointed manager of development and research, Superior Steel Corp., Pittsburgh.

Obituaries

CLAUDE BETHEL, manager of the railway engineering department, Westinghouse Electric & Mfg. Co., East Pittsburgh, since 1934, died recently following a brief illness. Graduating from the University of Arkansas in 1915, Mr. Bethel served as an artillery officer with the United States Army in France, joining the engineering department of the Westinghouse company at the close of the war.

♦ ♦ ♦

CHARLES S. LOCKWOOD, who for many years was chief engineer of the Hyatt Roller Bearing Co., died recently at the age of eighty-six. Mr. Lockwood had been connected with the various industrial enterprises of Charles Wesley Hyatt for 62 years, and until shortly before his death continued to be an active member of the Hyatt experimental laboratory staff. He was a prolific inventor, nearly 100 patents standing in his name. In addition to roller bearing developments his long experience covered such varied fields as celluloid, plastics and sugar mill machinery.

Professional Viewpoints

MACHINE DESIGN WELCOMES LETTERS SUITABLE FOR PUBLICATION

Let's Recognize the Designer

To the Editor:

MECHANICAL designers are, rightly enough, a retiring body of men. They don't seek publicity, and consequently don't get it. However, it is my opinion that many companies would benefit by telling prospective customers of the part the designer has played in the development of a new machine.

A purchasing agent often learns of a new machine through an advertisement. His comment is that the "A" Company has brought out a new machine. Now these machines don't just blossom into full bloom. Quite often they start from suggestions made by users of earlier models to the salesman. Or the designers, being their own severest critics, may be given the opportunity to make extensive improvements. Regardless of how the improvements are initiated, they are never suggested one week and then introduced the following week.

Every change made in a machine, every new material employed, every new part adopted spends months in the design department where it is studied, tested, and developed until finally, after months of work behind closed doors, the new design is introduced. Through all of this development the designing engineer plays a most important part. The advertisement which announces the new machine would never be published if it were not for these engineers. I believe that they deserve more notice and more credit. Perhaps some of your other readers believe the same.

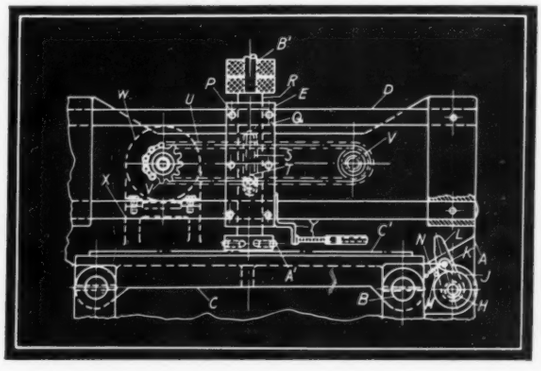
—PAUL HOFFMAN,
Lakewood, O.

Abraiding Action Is Simplified

To the Editor:

SMALL automatic abraiding machines of simple design find constant use in every branch of industry. In the experimental laboratories they are used for testing the life of materials and fabrics, crowding into a matter of days, years of wear. In the manufacturing departments they are employed for obtaining finishes of various types on products, such as sanding, polishing, graining etc. In the tool and machine shop they are employed for such operations as lapping, stoning, and final finishing of tool surfaces.

The accompanying drawing shows a low cost



Simple mechanism makes possible a low-cost device for securing abraiding action

construction for a machine of this type. It consists of base *A* which carries round lateral ways *B* for table *C* and longitudinal round ways *D* for reciprocating slide *E*. At *F* an extended bracket at both the front and rear of the machine carries a lead screw *H* which runs in a nut attached to table *C*. To this lead screw is attached ratchet *J* which is rotated by pawl *K* on rotating arm *L*. This arm is normally held in the forward position against pin *M* by spring *N*. On ways *D* is assembled slide *E*. Directly in front of the slide bores *P*, a vertical square slide *R* rides, and is held in place by cover *Q*. On the rear part of slide *E*, a vertical tee slot *S* is milled through. In this slot a tee-headed bolt *T* is inserted, the end of which forms the pin which holds one of the links of sprocket chain *U* together, thus the slide is attached to the sprocket chain by slidable tee-headed bolt *T*. The sprocket chain rotates around two suitably bearinged sprocket

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You can meet any of today's bearing requirements from M-R-C's twenty-three types. Every bearing incorporates design refinements resulting from 38 years of engineering experience. The high operating efficiency of M-R-C Ball Bearings is based upon manufacturing control that assures uniform production of all dimensions.

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shafts and sprockets *V*, one of which is coupled to motor *W*, fastened on shelf *X* on the rear side of base *A*.

On the side of slide *E* there is attached an adjustable pusher arm and rod *Y*, by which the amount of movement in a lateral direction of table *C* is controlled. At *A'* the two spring wire clips hold the abraiding material in place, while *B'* weights are placed so that the proper pressure upon the surface can be obtained. If desired, a counter can be added which will register the number of strokes over a given period of time.

In operation the work, *C'*, is suitably clamped upon table *C'* the abraiding agent inserted at *A'*, suitable weights *B'* placed on slide *R*, and pusher arm *Y* adjusted for feed of the table per stroke. If no feed of the table is desired the pusher arm is removed.

When the current is turned on the sprocket chain commences to rotate around the sprocket wheels. This causes tee-head bolt *T* to follow pulling slide *E* with it. Moving along the lower side of the chain, as indicated, it reaches the sprocket wheel and as the chain goes around the wheel the bolt slides upward in the slot after which the stroke is reversed as the top portion of the chain runs in the opposite direction. On the opposite wheel the reverse takes place, and thus the reciprocating motion is obtained.

—JOHN A. HONEGGER,
New York

Forming Increases Metal Value

SPRINGS which enter into the design of calculating machines in some cases are wound from 0.005-inch wire, to coiled diameter as small as 0.045-inch, and with as many as 18 coils in a length of ¼-inch. Tensile strength of the wire from which these tiny springs are made runs as high as 500,000 pounds per square inch, as compared to 60,000 for an ordinary steel bar, according to *Steel Facts*, published by the American Iron and Steel institute.

What manufacturing can do toward adding to value is demonstrated in a striking manner in the case of these small springs. When converted into them, steel actually becomes equivalent to a precious metal—having a value of $6.25 per ounce, as compared to silver at less than 50 cents per ounce.

The reliability of springs in common mechanisms is astounding but at the same time it is all too little appreciated. For instance, the hairspring of a medium priced pocket watch flexes 240 times per minute, which means 126,144,000 times per year. Operating as it does day and night, sometimes for several years without rest or renewal, such an element certainly represents a high degree of excellence in machine design as well as in refinement of material.

Tiny Mechanisms—Big Design Problems

(*Concluded from Page* 24)

and sapphires. They constitute the "jewels" or bearings in which the pivots of the wheels and pinions rest. Two types, bar jewels and oil hole jewels, are used. *Fig.* 3 shows an enlarged sectional view of the type of setting and jewel used on balance staff and escape wheel shaft, in which the jewel has been forced friction-tight into the setting, which in turn has been peened over it. *Fig.* 2 illustrates the relative positions of several jewels and settings. Inside and base of these jewel holes must be highly polished so as to leave no rough or sharp edges that would mar or cut the pivot. To accomplish this, the jewels are strung on a fine wire, diamond dust is placed on the wire, and the workman moves a cylinder which rolls them back and forth, thus polishing the inside of the minute parts. All pivots that are retained in these jewels are held within 0.0001 inch limit.

Combination Eliminates Extra Screws

Feet or pins *X Fig.* 2 are swadged on the dial as well as on the numerals, thus serving as anchors for fixing them in position. These feet eliminate the use of separate means such as screws and make the fastening integral with the part. This "one-piece construction" is particularly advantageous in view of the minuteness of the separate members that otherwise would be required.

Inherent characteristics of watchmaking place this business almost in a class by itself. Its problems are of such a specialized nature that they may seem at first glance to offer little for designers in other fields in the way of ideas. As a matter of fact, however, there are numerous points worthy of contemplation. For example, minuteness of parts would discourage the average designer and might prompt some to say, "It can't be done," were it not for the fact that it has been proved entirely feasible in the realm of watchmaking to carry out work of this nature. Drawings, such as *Fig.* 2, usually are executed on a 50 to 1 scale. This allows the man on the board an opportunity to visualize his problem without any restriction because of the actual size of the part. Use of profile projecting machines by the engineering department permits these minute parts to be "thrown up" on a screen and thereby studied in much the same manner as a mechanical engineer in the railway field might examine a locomotive driving rod.

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Could a customer tell you that your product does not live up to your claims — and get away with it?

Not if you have protected yourself with built-in counting devices. For then you have an accurate record of the number of operations, starts, stops, pieces or trips — of mileages, volumes, speeds or lengths — since the machine was first put in use.

To forestall unreasonable service demands, Veeder-Root Counting Devices are built into a great and ever-growing variety of products, including elevators, tractors, trucks, machine tools, typewriters, presses. Manufacturers are careful to secure service records not only for protection against "complaints"—but also for sales ammunition that hits the bull's-eye of buyer-interest: "What can this product do for us?"

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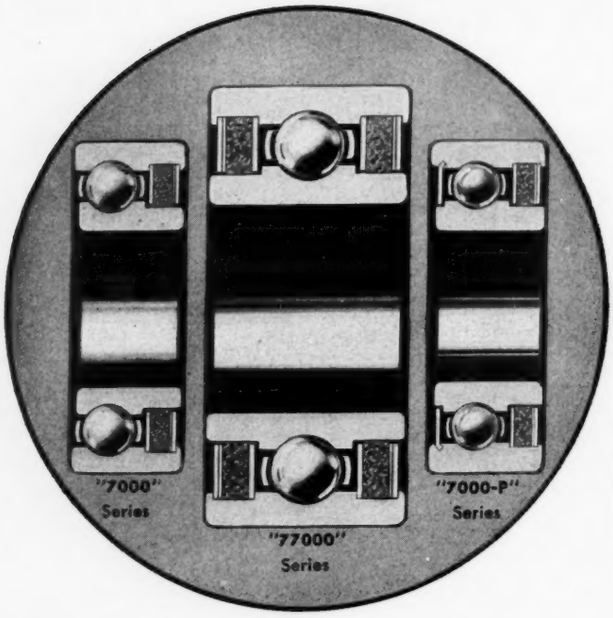

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Norma-Hoffmann "GreaSeal" Felt-Protected PRECISION Ball Bearings have the following outstanding advantages:

Thick, closely-fitting felts between removable plates, forming an effective labyrinth against recessed inner ring.

FELT SEAL REMOVABLE in its entirety, for inspection, cleaning, or renewal of grease.

Wide inner and outer rings, with maximum contact on shaft and housing, make inserts in housing unnecessary and militate against slippage, looseness and escape of lubricant past outer ring.

Felt seal entirely within confines of both rings; therefore not exposed to injury.

Seal construction avoids race distortion, assuring dimensional exactness and quiet running.

Grease capacity ample for long periods.

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PRECISION BEARINGS
BALL, ROLLER AND THRUST
NORMA-HOFFMANN BEARINGS CORP'N., STAMFORD, CONN., U. S. A.

Noteworthy Patents

NOVEL combination of parts is embodied in a newly patented clutch, *Fig.* 1. Loring P. Crosman is the inventor and Gardner Co., Orange, N. J., assignee of the patent, designated 2,036,400. The clutch is normally held out of engagement by contact of a roller *P* of pawl *O* with a shoulder *R* of a floating abutment arm *L*, the arm being pivoted at *T* on an arm *U*

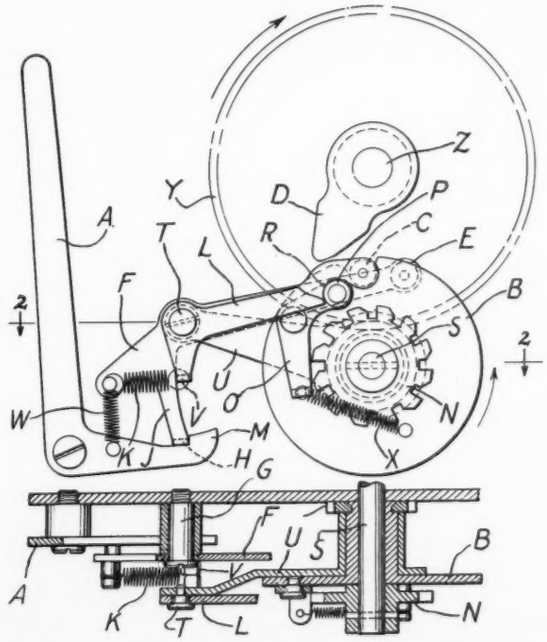

Fig. 1—Relieving of clutch parts from driving friction during disengaging action permits the teeth of disk N to be made of considerable depth

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AIRCRAFT construction demands the very utmost in steel dependability. . . . Forgings get the most meticulous inspection. Seams or blemishes too small to be detected by the naked eye are enough to cause rejection.

Chrome-Molybdenum (SAE 4130x) steel forgings have repeatedly proved themselves able to pass the most rigid tests with a minimum of rejects. They reduce machining costs as well.

This characteristic is true of all Molybdenum steels used for forgings. . . . Reject percentages, material costs and labor costs—all are lower, while the quality of the forgings is uniformly high.

Whether or not your forging requirements call for close inspection, it will pay you to investigate Moly steels. Write for our helpful technical book, "Molybdenum." On request, we will also gladly put you on the mailing list of our news-sheet, "The Moly Matrix." And if you are interested further—in some particular ferrous problem, for instance—our experimental laboratory facilities are at your disposal. Climax Molybdenum Company, 500 Fifth Ave., N. Y.

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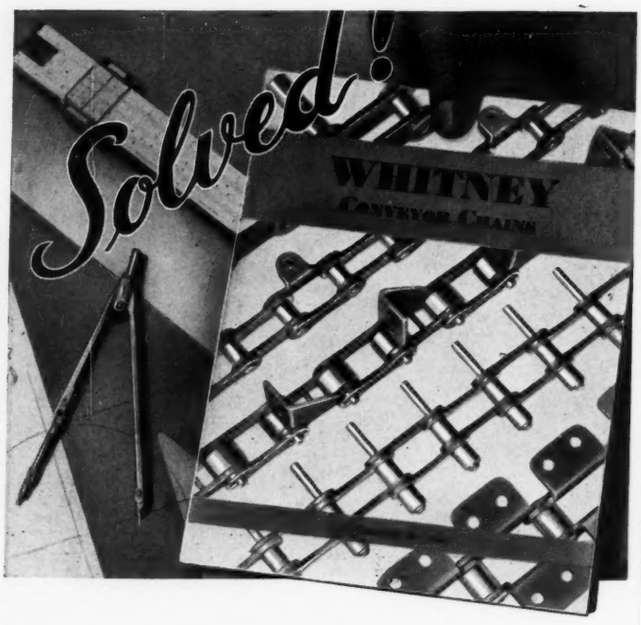

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Manufacturers in many lines of industry have found that Whitney All-Steel Conveyor Chains offer definite advantages on their conveyor applications. These chains are particularly designed for conveyor applications within machines where accuracy and finished appearance are essential.

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Whitney engineers can offer valuable suggestions in the design of your conveyor drives. Write for catalog V-116 A, and further information.

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Address .....

mounted in concentric relation to the clutch members.

Abutment member *L* is controlled by a spring-urged lever *F* fulcrumed to the frame at *G*, spring *K* normally holding lug *V* of arm *L* against a lower extension *J* of the lever. In the normal position of the parts, lug *H* of extension *J* is engaged by latch *M*, held in engagement by spring *W* and having an extension *A* that forms a trip lever by which the latch may be released and the clutch engaged.

Clockwise rotation of lever *A* frees lug *H* from latch *M*, rocking lever *F* counterclockwise about fulcrum *G*, the extension *J* through contact with lug *V*, and also acting to lift abutment arm *L* so as to move shoulder *R* out of contact with roller *P*. Thereupon, spring *X* will move pawl *O* into engagement between the teeth of driving member *N* and movement will be imparted from shaft *S* and member *N* through pawl *O* to the driven member *B* and thereby to gears *Y*. Rotation of the driven clutch member or disk *B* will carry the notch in the disk out of register with roller *C* mounted on the end of arm *L*, the peripheral portion of disk *B* preventing return movement of arm *L* until a full cycle of rotation of shaft *S* has brought the notch of the disk again opposite roller *C*.

Assuming that the operator has released lever *A* before the arrival of the notch in disk *B* opposite roller *C*, a relatching tooth *D* mounted on driven shaft *Z* will contact a roller *E* on the end of lever *F*, rocking the lever clockwise about fulcrum *G*, relieving lug *H* of pressure from extension *J* and tension spring *K*, to return arm *L* to normal position. At the same time lug *H* will be re-engaged with latch *M*. Thereupon, roller *C* will move down the cam wall of the notch of disk *B* under pressure of spring *K*, moving driven member *B* forward with relation to driving member *N*, thereby relieving pawl *O* of the excessive friction due to driving contact with the teeth of disk *N* fixed on drive shaft *S*. Finally, as roller *C* reaches the bottom of the slot, roller *P* of pawl *O* will contact with the shoulder *R* of abutment arm *L* to rock the pawl out of contact with the teeth of disk *N* and bring the disengaged parts to rest.

VIBRATIONS of the driving member are not transmitted to the driven member in a belt drive recently patented by Edmund R. Morton and assigned to Bell Telephone Laboratories Inc. Turntable *A*, *Fig.* 2, is rigidly secured by dowel pins to a suitable pulley *B*. Mounting bracket *C* for motor *D* swings about a pivot *E* in one of the arms of spider *F* which consists of a pair of L-shaped members resiliently held in spaced relation by large rubber washers *G* and

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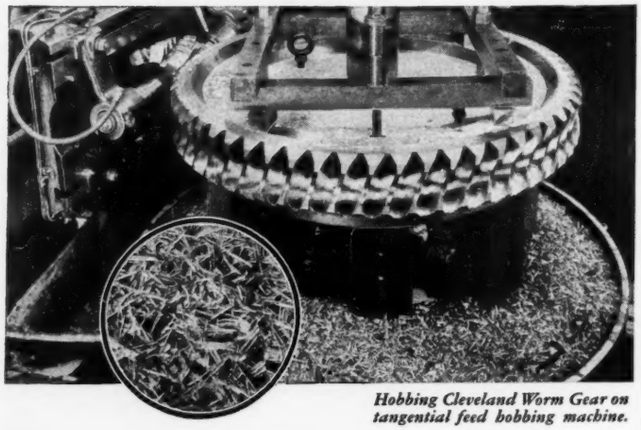

Hobbing Cleveland Worm Gear on tangential feed hobbing machine.

Return to the "CLEVELAND" *melt*

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Design Engineers . . . **Every pound of borings produced while manufacturing Cleveland Worm Gears is sold for scrap. "Cleveland" does no remelting. Cleveland Worm Gears are of *virgin metal.***

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Does your "Cleveland" information file contain *enough* live data? It will be a pleasure to supply you with all the latest facts. 'Phone our nearest District Office, or write:

The Cleveland Worm & Gear Company, 3275 East 80th Street, Cleveland, Ohio.

Affiliate: The Farval Corporation, Cleveland, Manufacturers of Centralized Systems of Lubrication

CLEVELAND WORM GEAR *Speed Reducers*

smaller similar washers *G'*, member *H* being secured to the U-shaped member *J* on pivot *E*. The lower arm of this latter member has an extension piece *K* from which a spring *L* extends to a bracket on the spider to maintain a slight initial tension in belt *M*.

Motor *D* is secured to member *N* by screws which engage the housing of the motor thrust bearing. Members *N* and *H* are aligned with pivot *E* and held together by screws *X* and *S* located in the members so that a line *O* through these points of attachment passes approximately through the center of mass *P* of the motor, the upper screws being substantially in the horizontal plane of the belt.

Resultant belt pull *R* (in diagram) is normally through pivot *E* and tends to rotate the motor about a horizontal axis through its center of mass but since the washers *F* are at some distance on opposite sides of this center of rotation and in the vertical plane indicated by the line

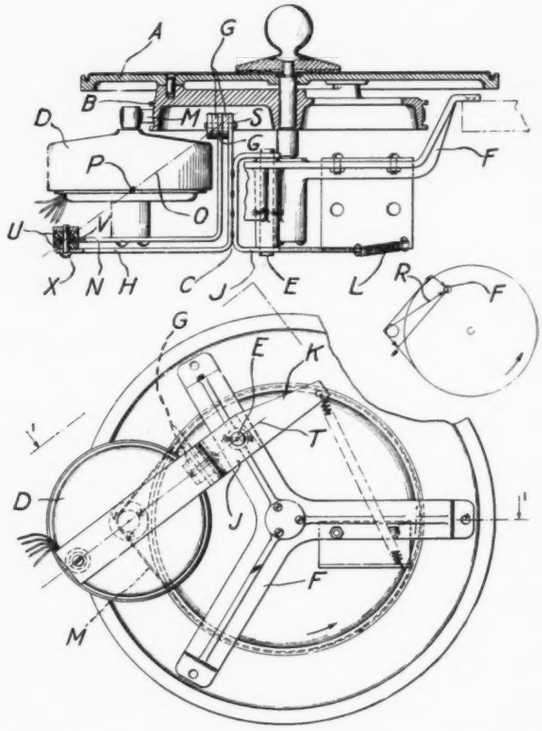

Fig. 2—Transmission of vibration from driving to driven member is obviated in this belt drive

T through the center of mass *P* and pivot *E*, they offer a high resistance to further compressional forces so that the motor shaft is not materially deflected from its vertical position. Washers *U* and *V* are relatively free to deflect laterally, however, and extraneous vibrations originating in the motor are accordingly dissipated in the mounting and are not transmitted to the turntable *A*.

No. 2,022,052 identifies this patent.

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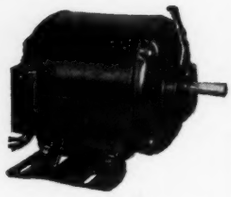
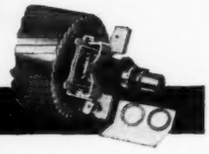


1 ● **Rotor** is dynamically balanced to eliminate vibration and noise arising therefrom. The number and the dimensions of rotor slots are carefully chosen to minimize magnetic noise.

DYNAMICALLY BALANCED ROTORS

2 ● **Cork Thrust Washers** located at both ends of the motor cushion the free-end movement of the rotor thereby preventing noise.



CORK THRUST WASHERS

3 ● **Steel-backed Babbitt-lined Bearings** are diamond-bored to secure bearing clearances small enough to avoid any possibility of excessive play and at the same time have ample clearance to afford a liberal oil film between shaft and bearing.

DIAMOND-BORED BEARINGS

4 ● **Resilient Mounting,** interposed between motor frame and base, is made up of layers of rubber and steel vulcanized together — is elastic enough to absorb the small amount of vibration remaining in the most carefully-designed motor.

RESILIENT MOUNTING

There are many other features of Wagner small motors, contributing not only toward quiet operation, but toward such essentials as dependability, performance, simplicity, and appearance. These features are fully described in Wagner Small Motor Bulletin 177, which will be sent upon request.

Wagner Electric Corporation MS336-2L

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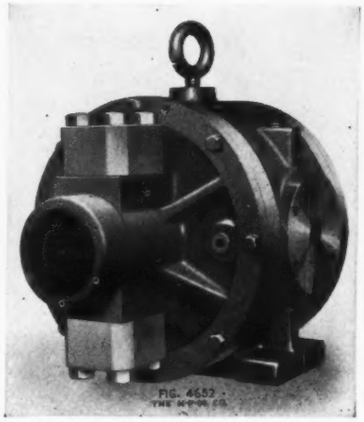
NEW *Materials and Parts*

Pumps Provide New Relationship

RADIAL pumps which provide a new mechanical relationship between the valve pintle and the cylinder rotor are a recent development of Hydraulic Press Mfg. Co., Mount Gilead, O. The new model 4R design, shown herewith, gives a definite and certain result, assuring positive positioning of these parts. In the design, the cylinder rotor is mounted directly on the central distributing valve through precision bearings which have less clearance than the allowable clearance between the two working parts. These bearings are provided with a take-up adjustment so that the proper bearing clearance may be maintained indefinitely.



Cylinder rotor is mounted directly on the central distributing valve through precision bearings in this improved radial pump

---

Open Mesh Conveyor Introduced

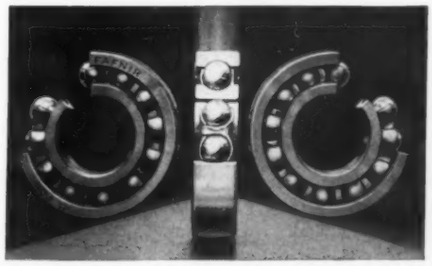
OPEN mesh conveyor chains, particularly designed for service in glass manufacturing machinery, are a recent innovation of Whitney Chain & Mfg. Co., Hartford, Conn. For this application, the chains, shown herewith, offer smooth flat conveying surfaces, consistent with the need for an open mesh which will allow free flow of a cooling blast through the chain. The parts can also be used in many cases where a flat metallic belt conveying medium is required. Each chain is made from standard units, to the

. . . *the basis of your saving*

Forging the rings that later become raceways, from carefully selected bars of specially developed steel, is the foundation of the long, friction-free life which Fafnir Ball Bearings provide. The marked improvement in grain structure gained by this forging operation is just one of the hidden factors that contribute to the long-wearing, stress- and strain-proof performance that characterizes Fafnirs.

Such qualities pay greater and greater dividends as time goes on. Extreme accuracy and long life are direct results.

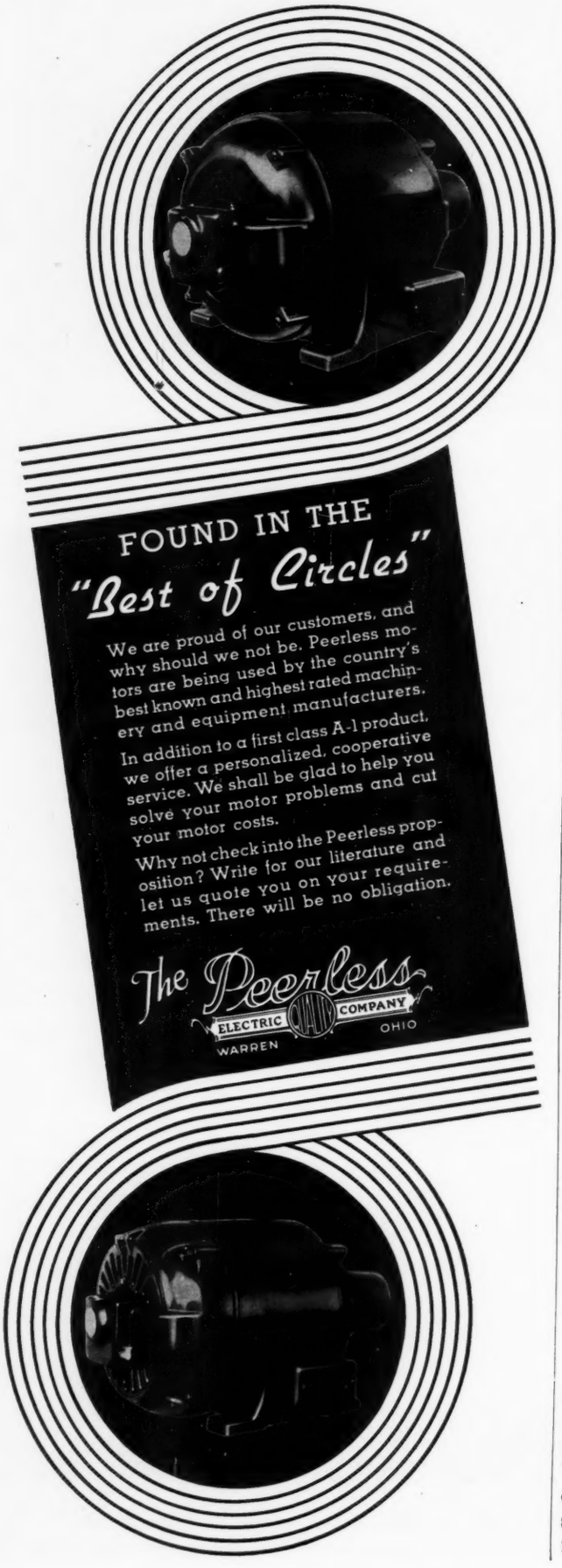
There is a Fafnir Ball Bearing that exactly fills every requirement. Backed by the most complete line of types and sizes in America, Fafnir engineers can always help you select the bearing best suited to *your* needs. . . . The Fafnir Bearing Company, *New Britain, Connecticut* . . . Atlanta . . . Chicago . . . Cleveland . . . Dallas . . . Detroit . . . Kansas City, Mo. . . . Milwaukee . . . Minneapolis . . . New York . . . Philadelphia.



Forging is one of the 77 operations in the manufacture of a Fafnir Ball Bearing, of which this Single Row Bearing is a representative type.

FAFNIR

BALL BEARINGS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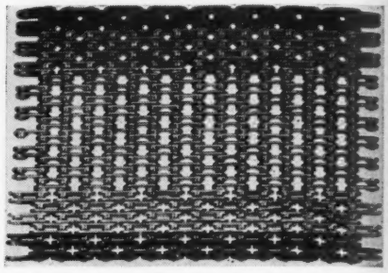
desired width. Chains in these series can be made entirely of steel, steel with bronze center links or stainless steel according to the needs of the particular application.

Construction of these chains is such as to provide a balanced design in any width with ample strength and bearing area. A unit link and bushing construction insures proper link spacing and with hardened coating on pin gives resistance to wear and chain elongation. The chains are driven by a wide face silent chain sprocket engaging with silent chain link units in the center of the conveyor chain. Sprocket teeth are cut with standard silent chain cutter sprockets. All links are of the same height.



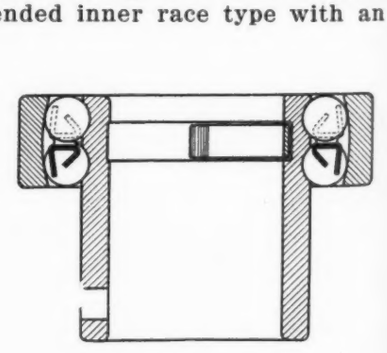
Free flow of cooling blast through the chain is practical with new design of open mesh conveyor chain

---

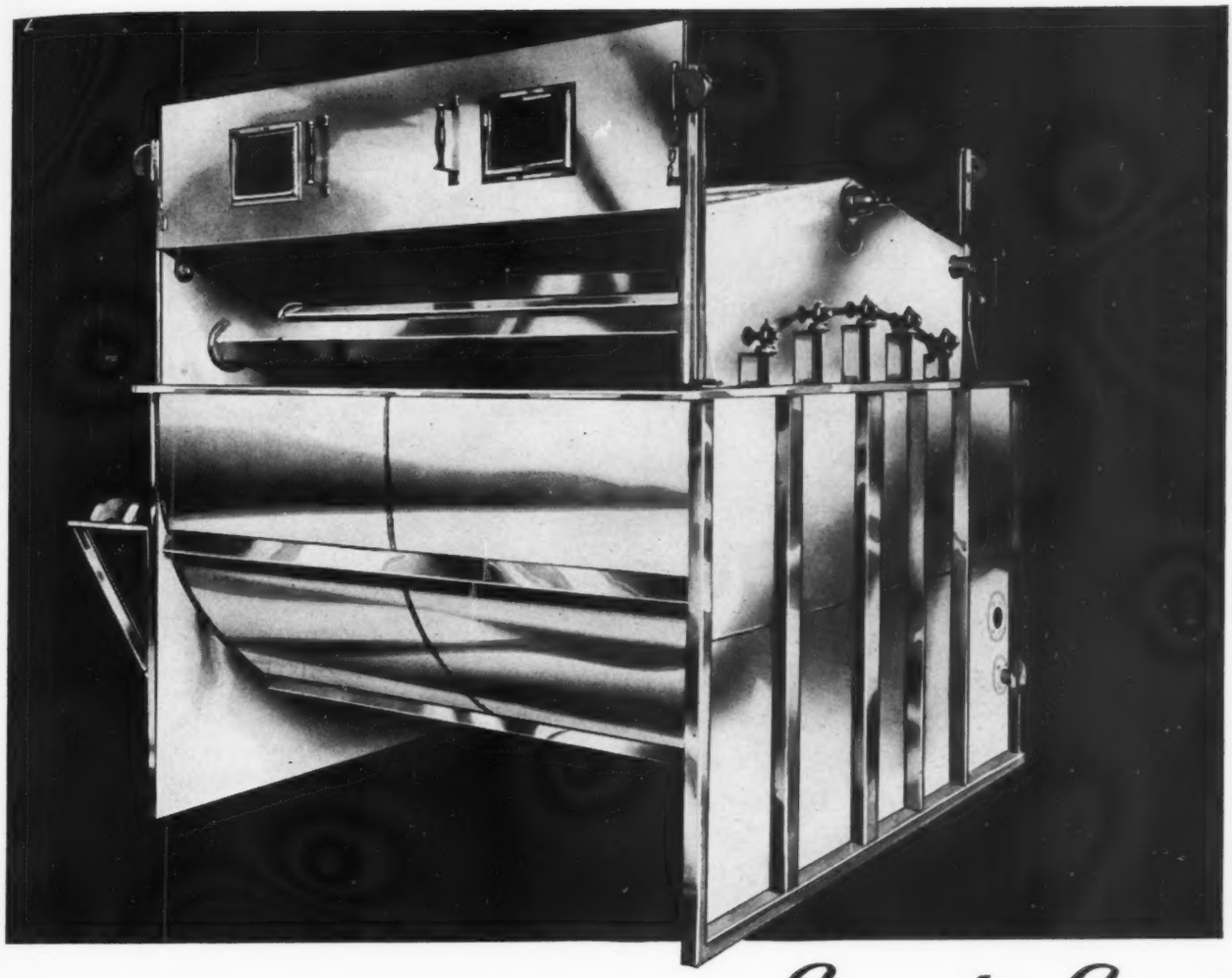
Bearings Grip the Shaft

GRIP-lock bearings as shown in the accompanying illustration are the latest addition to the line of anti-friction bearings manufactured by SKF Industries, Front and Erie avenue, Philadelphia. The griplock principle offers the advantage of quick, simple application of the bearing without tools and insures positive locking to the shaft.

Essentially, the bearing is the conventional self-aligning extended inner race type with an eccentric groove machined in the bore of the inner race. Fitted in the eccentric groove is a piece of spring steel known as the grip-lock shoe. When the shoe is in the deepest part of the eccentric groove the bearings may be readily slipped on the shaft. Then, by holding the inner race of the bearing while the shaft turns in the



Grip-lock shoe in eccentric groove in the bore of the inner race locks the bearing in position



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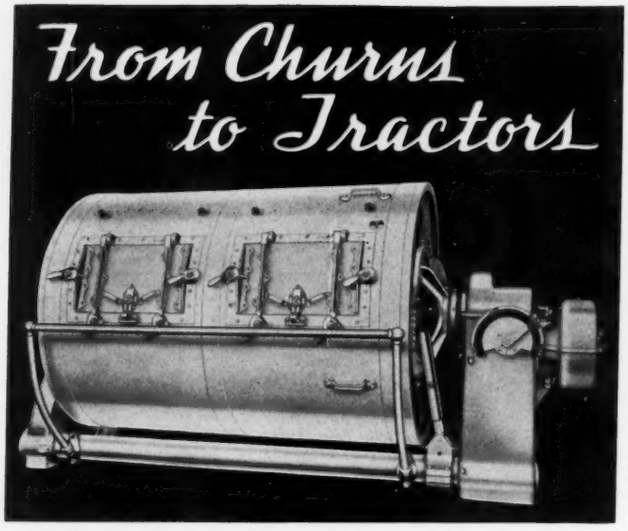

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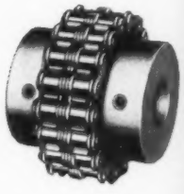
Write* for specific recommendations. Engineering data on request. *Twin Disc Clutch Company, 1325 Racine St., Racine, Wisconsin.

TWIN DISC
CLUTCHES

direction of operation, the knurling at the ends of the grip-lock shoe grips the shaft causing the shoe to wedge in the shallow part of the eccentric groove thus securely locking the bearing on the shaft.

Improves Chain-Type Couplings

FLEXIBLE couplings of the chain type in an improved design are a recent development of Diamond Chain & Mfg. Co., 435 Kentucky avenue, Indianapolis. The coupling of the new series consists of two sprockets encircled by a length of double-strand roller chain. Clearance

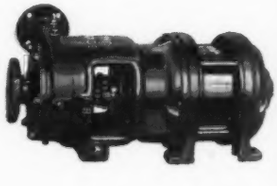


Use of double-strand rather than single-strand chain gives flexible coupling more horsepower capacity for a given size

is provided between the sprocket teeth and the chain side plate to permit misalignment of the connected shafts. The flexibility is in the design, and adequate flexibility is secured together with the strength and durability of steel. All couplings in the company's line are now made with double-strand chain instead of single-strand. This gives a coupling of a given size more horsepower capacity and also permits its use on larger shafts for given outside diameter than the former design.

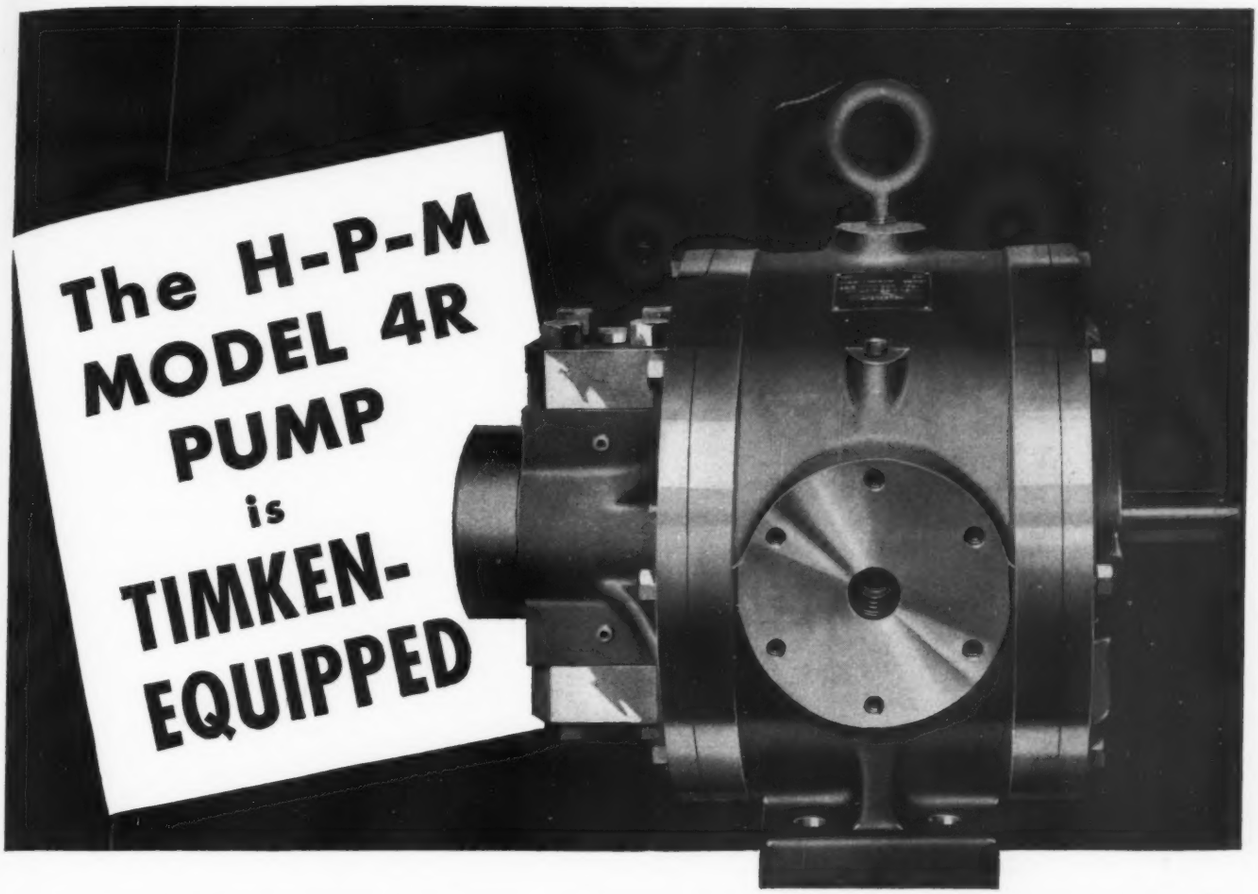
Announces New Motor-Driven Pumps

DESIGNED for general service pumping where small space and low weight are essential, the new 3620 motor-driven centrifugal pumps developed by Goulds Pumps Inc., 75 Fall street, Seneca Falls, N. Y., are available in standard



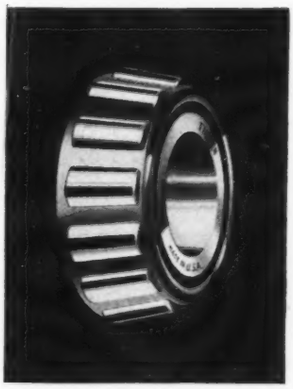
This motorized pump is designed for general service pumping where small space and low weight are essential

and special constructions for the handling of ordinary and corrosive industrial liquids. Fifteen sizes are being offered in capacities from 5 to 1600 gallons per minute. The combining



Timken Bearings are associated with more new developments in industrial equipment than any other type of bearing. The reason is found in the threefold protection the Timken Bearing affords by eliminating friction; carrying all types of loads—radial, thrust or both together in any combination; and holding moving parts in correct and constant alignment.

The Hydraulic Press Manufacturing Company, Mount Gilead, Ohio, has taken full advantage of Timken Bearing efficiency and versatility in developing its new Model 4R Radial Pump for hydro-power press equipment. This unit introduces a new principle in radial power pump design based upon a new and more accurate relationship between the central distributing valve pintle and the primary rotor which revolves around it.



By mounting the rotor upon Timken Bearings the necessary minimum clearance for oil film between the rotor and pintle is held constant under all operating conditions, thereby preventing metal-to-metal contact and consequent damage to these vital parts. Furthermore, the load is concentrated upon the bearings instead of on the oil film—another valuable safeguard under high working pressures. At the same time thrust loads, as well as radial loads are adequately provided for.

It pays to have Timken Bearings in every kind of industrial equipment you manufacture or use.

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of pump and motor in a single unit permits reductions in overall dimensions and weight without sacrificing strength or durability.

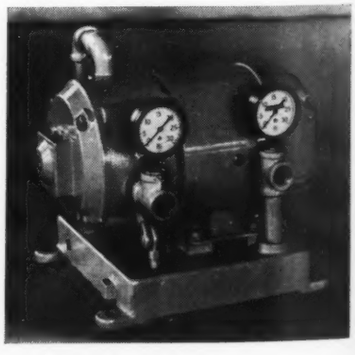
All moving parts in the unit are mounted on a single oversized shaft which runs in heavy duty ball bearings. Impellers are of the enclosed single suction type, mechanically and hydraulically balanced, and are keyed and locked to the shaft. Casings may be swiveled to any of four positions and are equipped with priming, drain openings and air vent cock.

Nozzle Is Nonclogging

A SIMPLE nonclogging spray nozzle for spraying, washing or cleaning all kinds of materials, screens, fruit, vegetables, etc., has been devised by Link-Belt Co., Chicago. The nozzle has been described as a scientifically shaped, smoothly polished curved bronze deflector with U-bolt for clamping the deflector securely to the water pipe in such position that it is just above the orifice, a plain drilled hole, in the wall of the pipe. The width of the deflector permits a comparatively large water jet and thus allows fairly large dirt particles to pass through the orifice without clogging it.

Combines Motor and Air Pump

ABOUT the same size and weight of standard motor and base combined, the new Motoair unit of Steel City Electric Co., Pittsburgh, provides motor and air production mechanism as a single unit. In the design of the equipment, shown herewith, auxiliary driving means has been eliminated. A fan cools the unit while pure air is assured as the device has a base type oil condenser. This eliminates the possibility of oil from the oiling system getting into air lines, either pressure or vacuum. An entirely auto-



Auxiliary driving means has been eliminated in design of combined pump and motor

Here is a Warner & Swasey turret lathe at work making gear blanks of chrome nickel steel. Such work demands power, speed, and accuracy.

Hyatt Roller Bearings enable Warner & Swasey Turret Lathes to maintain high standards of performance day in and day out, year after year.

When it depends on bearings . . . depend on HYATT

Hyatt's service to industry goes far beyond the meeting of mere specifications. It lies in constructive help to designers, manufacturers, and engineers . . . in new ideas, new products, new ways of doing things.

And wherever Hyatt Roller Bearings are employed, you can count on the saving of all possible power, lubricant, and operating costs. But this is just the beginning of Hyatt economy. Long after being completely written off, Hyatt-equipped machinery continues its better, low-cost production.

Small wonder, then, that when it concerns bearings, equipment builders depend on Hyatt. Hyatt Roller Bearing Company, Newark, Detroit, Chicago, Pittsburgh, San Francisco. In Europe, 111 Grosvenor Rd., London.

H Y A T T

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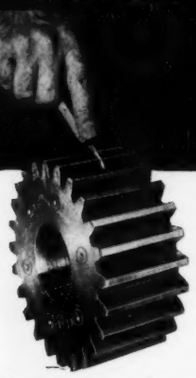
PRODUCT OF GENERAL MOTORS

The Gears that Insure *both* Strength and Silence!



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No other gear gives *all* their advantages!

The laminated construction eliminates noise.

Made of all-steel they provide maximum strength.

With a tooth profile not subject to deformation, wear is reduced and service life increased. Compared from any angle with non-metallic gears, the Waldron Silent Steel Gears prove much more efficient and economical to use on drives.

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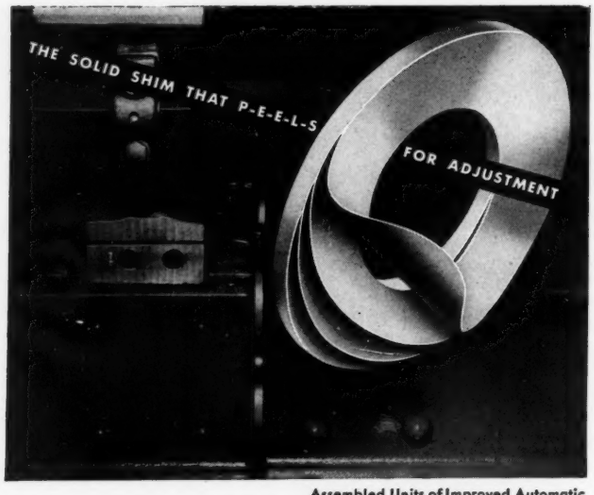


Assembled Units of Improved Automatic Spooler—Barber-Colman Company.

quick assembly spacing

For precision spacing of bed sections to fit the drum units, Barber-Colman utilizes Laminum shims. Quick; accurate . . . lower assembly cost. You simply p-e-e-l one or more laminations at a time from the brass shim. Write for sample.

THE SOLID SHIM THAT P-E-E-L-S FOR ADJUSTMENT

LAMINUM

578

LAMINATED SHIM CO., INC. 21-26 44th Ave., Long Island City, N.Y.

matic pressure oiling system is employed on the unit.

The device has been used on automatic feeders for pile feeding of paper, etc., on printing presses, envelope, glueing, folding, tagging, packaging, bottle filling, capping, labeling and paper box making machines and on other types of production machinery requiring constant or intermittent air or vacuum. It has a wide range of service for use on production machines for removing cuttings, etc. Its compact design permits its installation on the machine itself. Both single and double units in a variety of sizes are available.

Wire Connectors Are Compact

THREAD-ON wire connectors of unusually small size which can be used in place of solder-and-tape wire joints, terminal blocks and binding posts are now being manufactured by Ideal Commutator Dresser Co., 1442 Park avenue, Sycamore, Ill. The midget connector shown herewith, No. 71, is designed for two No. 16 or two No. 18 wires or equal combinations, and is 17/32-inch long and 0.105-inch wide. In addition to permitting an improvement in appearance, this connector is extremely easy to apply. It has been used in the design of motors, machines and tools of every sort including small kitchen appliances and large industrial equipment.

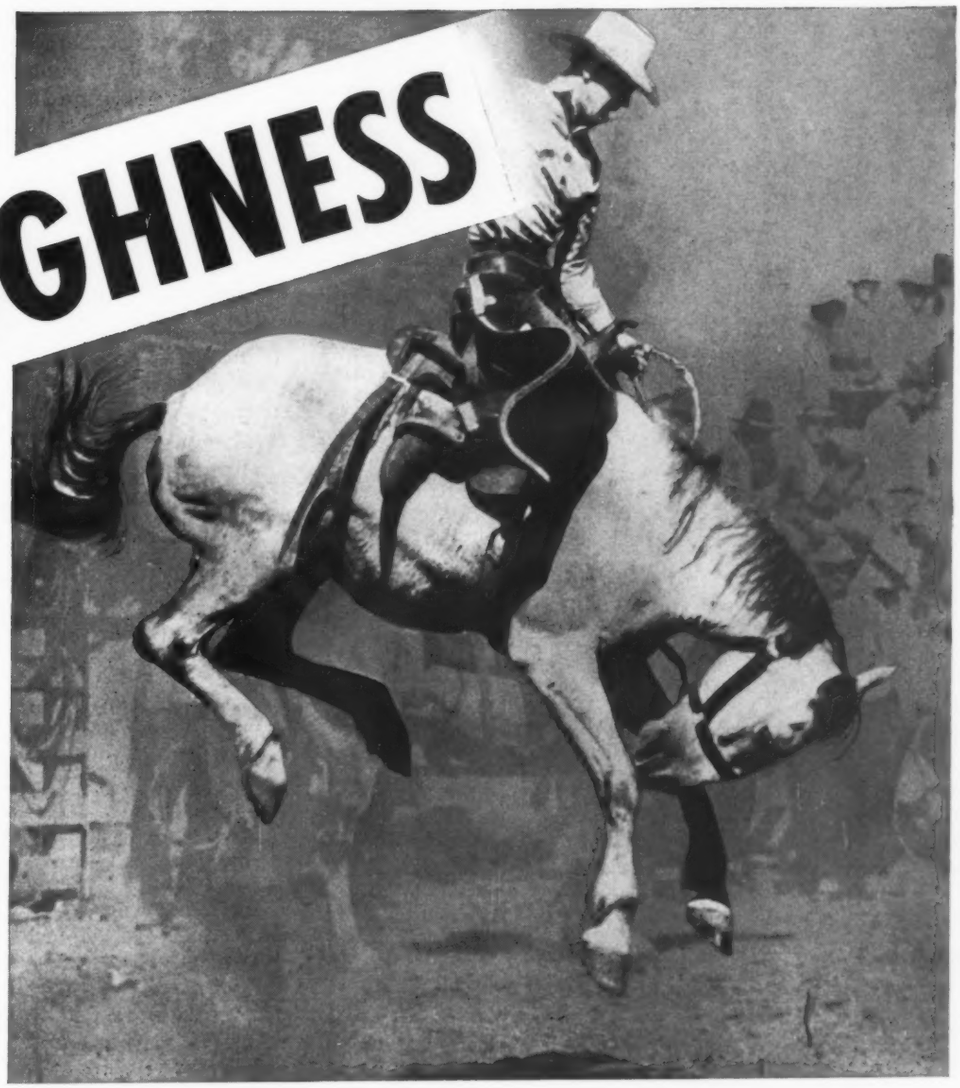
Simplicity of application is a feature of thread-on wire connectors which are of unusually small size

Announces New Type Air Hose

AIR HOSE in a new design for all types of air tool applications has been announced by B. F. Goodrich Co., Akron, O. This hose is unique in that it is a combination construction made in long lengths. The inner carcass consists of four plies of specially woven duck. The outer carcass is a tight braid of high tensile cords which are applied with a tension ten times that normally used on long length braided hose. Between the inner and outer carcass is a substan-

TRUE BREED

TOUGHNESS



. . . Where it's essential, design the part for forging . . .

Forging hammers toughness into millions of steel fibers —fibers formed and compacted by rolling and hammering (directional working) the steel.

TRUE BREED characteristics underlie toughness in forgings. Forging kneads millions of fibers of steel into tough sinews and creates many exclusive characteristics. Toughness is that quality embodied in forgings which yields but sustains unfaltering performance. Bulwarked by a generous measure of strength inherited from the forging process, forged parts never flinch but incessantly absorb shocks and endure unrelenting strains and pressures. Toughness, strength, stamina, flexibility—these qualities, imparted to your products through forgings, translate into safety and dependability. Designing for forging isn't difficult or complicated. Invite the counsel of competent forging engineers. They can help you work out improvements in your product.

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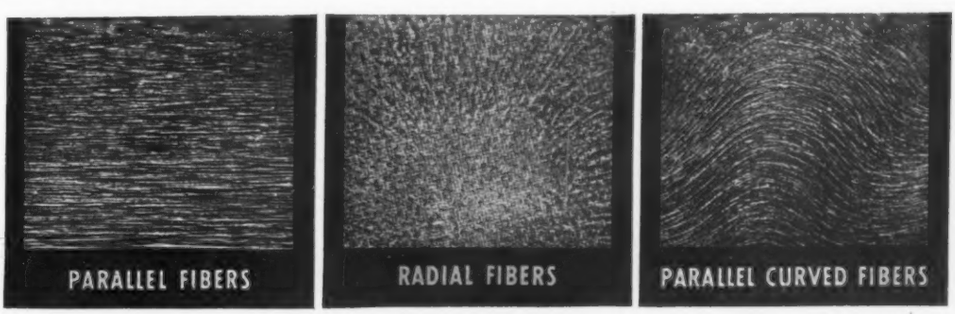
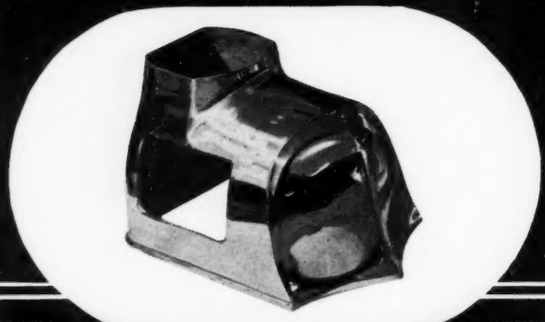


DROP FORGINGS ARE THE SINEWS OF COUNTLESS USEFUL THINGS

Waukesha
METAL
"A Nickel Alloy"

Waukesha Metal is a corrosion-resisting, high nickel content, casting alloy, used especially in the fabrication of food handling equipment. Illustrated below is a typical Waukesha casting, an ice cream freezer base weighing approximately 52 lbs. and polished to a high buff finish.

Waukesha castings are nonporous, easily machined and polished and can be cast from patterns used for bronze or iron. Various strengths and hardnesses are obtainable.



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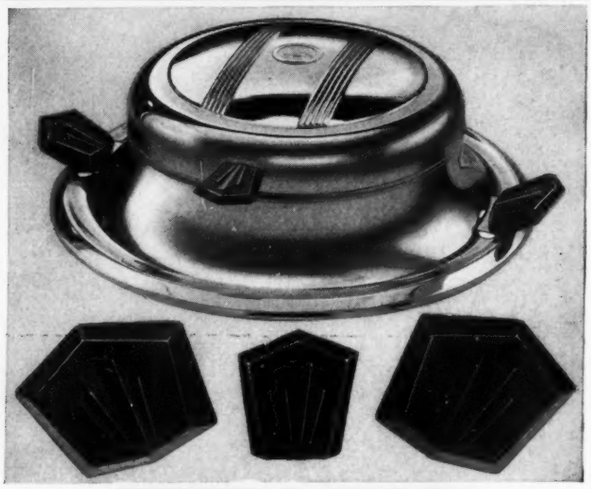
WAUKESHA, WISC.



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Handles of molded plastic material are a small but important part of any electric appliance. They provide the ideal insulation against heat and electricity, while their handsome appearance adds appreciably to the selling appeal of the article.

National Stamping & Electric Works, manufacturers of the famous White Cross electric appliances chose this organization to produce the handles for their new waffle iron, because, like many other nationally known firms, they have found here the engineering skill and molding facilities to meet their most exacting requirements. You, too, may find this the best place to secure your molded parts.

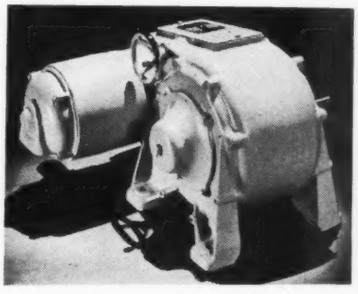
CHICAGO MOLDED PRODUCTS
CORPORATION

2147 Walnut Street *Chicago, Ill.*

tial insulation which serves as a secondary tube to seal off penetration of air through the walls of the hose and to cushion blows from the outside. The tube is made of a special rubber capable of resisting both oil and heat.

Wide Mounting Variations Available

AN IMPROVED drive unit, known as the Speed-Trol unit, a compact, enclosed, self-contained, infinitely variable speed power drive, has been brought out by Sterling Electric Motors Inc., Telegraph road, Los Angeles. The unit, shown herewith, is featured by universal mounting. It can be furnished without motor or with alternating or direct current motors such as open, enclosed fan cooled, pipe ventilated, explosion-proof, 2, 3 or 4 speed, NEMA dimensions, etc. It can be assembled with either single or multiple reduction standard gears making available any speed desired at the output shaft. The feet can be left off making the unit adaptable for building into machines. The entire unit can be mounted in any position, shaft up, shaft down, with ring bases or flanges on bottom or top of both.

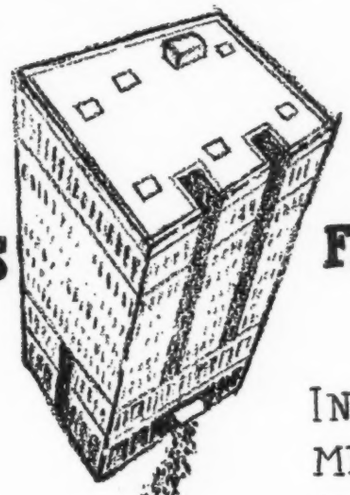


Gears, infinitely variable speed device and motor are combined in one in new unit

Flexible shaft, rod, chain, electric and various handwheel and lever controls are available including many forms of automatic and differential control which automatically change or pre-set the speed by the movement of a lever, variations in pressure, changes in temperature or humidity, or any other industrial process requiring speed changes.

Back-Geared Motors Are Improved

A NEW "flea power" worm drive, back-geared motor that comes not only in alternating, direct and universal current models, but at the same time can be assembled with drive shaft to right, to left, up or down is a recent development of Speedway Mfg. Co., 1834 South Fifty-second avenue, Cicero, Ill. Other features of



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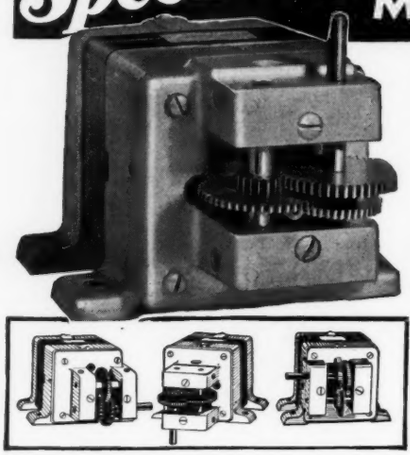
SpeedWay Flea Power **MOTORS**



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Cased and Skeleton Types

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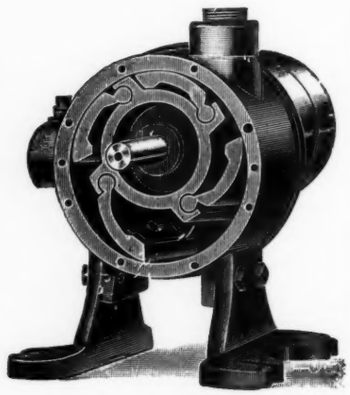
This is the heart of the machine



And every machine, like every man, is benefited by having a good heart—one that responds when called upon for its best efforts, not one that quits when it is most needed. And in this instance it costs no more when you get a machine with this good heart—the most powerful and long-lasting air pump made.

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PATENTED ROTARY POSITIVE
AIR PUMPS
They Take Up Their Own Wear

Also Used for VACUUM or PRESSURE	for VACUUM PRINTING FRAMES, COOLING MOULDS, AGITATING LIQUIDS, STEREOTYPE MELTERS	Also Used for GAS and OIL Furnaces

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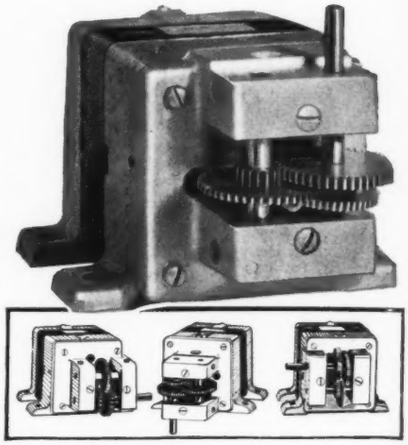
LEIMAN BROS., N. Y. CORP., 23 P4 Walker St., New York City
Makers Of Good Machinery For Over 45 Years

these new motors, shown herewith, include: Quietness resulting from an improved worm on the primary reduction and straight, wide faced, cut steel gears on the final reduction; matched end castings, one of which carries all reduction gears that fit evenly to the motor case; a wide

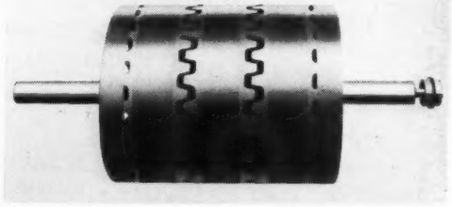


Flea power, worm drive, back-geared motors can have output shaft in a variety of positions

range of selected speeds on the final shaft—1, 7, 11, 40 or 80 revolutions per minute on the alternating or direct current unit, for example, as standard speeds with many others available; small size, 2½ by 3 by 4 inches including the reduction gears; high starting torque; and low inputs from 4 to 15 watts.

Provides Large Radiating Surface

FIFTY per cent greater radiating surface than in other designs of the company is provided by the new magnetic pulley of Dings Magnetic Separator Co., Milwaukee. The horizontal and radial surfaces of this pulley, shown herewith, are corrugated or ribbed like the surface of an air cooled gas engine cylinder. The conveyor



Maximum amount of radiating surface is provided to cool this magnetic pulley

belt forces the air downward through the radial openings and out through the longitudinal ducts, both corrugated, and therefore presents the maximum amount of radiating surface. Heat generated in the coils is conducted from them through the conductive dynamo steel poles and

cores and is dissipated. The corrugated radial openings shown in the illustration are centrally located in each magnetic pole. Bronze spacer rings, not steel because these short-circuit the lines of force, bridge the gap between the poles.

The pulley shaft is turned and polished. Where heavy strains are encountered a special high tensile steel shaft is supplied. The shaft dimensions are made to conform to those of an existing head pulley when the latter is replaced by a magnetic pulley. Standard equipment supplied with the magnetic pulley consists of net collars, bronze slip rings mounted upon the shaft, double-contact brushes on each slip ring to preclude arcing and excessive wear, a dust-proof collecter ring housing and an approved steel switch cabinet with fused switch, bulls-eye indicator to show when current is flowing, and a special kick absorbing resistance which absorbs the counter EMF when the circuit is opened.

Welded Shapes, Alloy Castings Reduce Weight

(*Continued from Page* 35)

angle, for the ten units of this order built by St. Louis Car Co. and Lukenweld Inc. Introduction of formed plate sections became economically attractive. It was also considered advisable to apply the swing link bearings (which had been built into the original frames) at the final assembly of the truck. Small pads, machined to take the bearing blocks on the final assembly, welded to the top flange of the transmission members, eliminated the drilling and boring operation which would have been relatively costly if done on the completed frames.

Consideration of contours at the intersection of formed sections, plus the small details incidental to the support of brake rigging at these points, dictated the use of Cromansil steel castings in the corners where the transom intersects the side members.

In the new design of welded truck, an important change was the introduction of single shoe brakes. The two brake cylinders were located at the extreme ends of the truck, diagonally opposite. The small details, the box section necessary to resist lateral stresses set up by cylinder reactions, and the quantities involved, combined to indicate the desirability of cast steel pedestals, which were made in Cromansil analysis. These castings cease, and are butt-welded to the ¼-inch formed side member sections, at points immediately behind the inner journal box guides. Due to their complicated nature, the thinnest metal section that could be obtained, consonant with sound castings, was ⅜-inch.

At a center plate loading of 34,000 pounds, the design stress in these trucks is approximately

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1 Full roller bearing capacity for radial, or thrust, or combined radial-thrust loads.

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Single and double row radial-thrust Shafer Roller Bearings available in sizes from ⅝ in. to 9½ in. and larger. Also supplied in stock mounted units—Pillow Blocks, Cartridge Units, Hanger Boxes, Take-up Units, Duplex Units, Flange Units, Conveyer Rolls.

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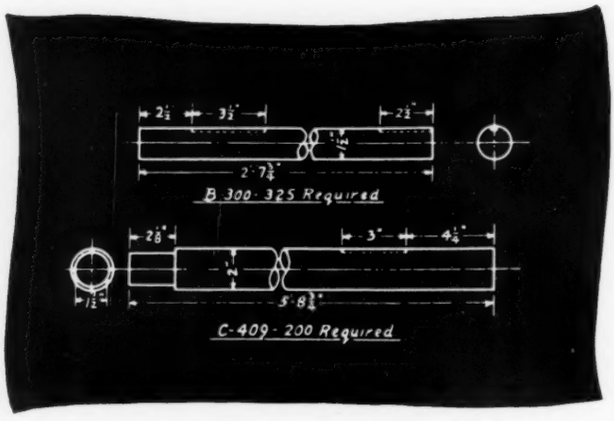
RADIAL-THRUST ROLLER BEARINGS



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24,000 pounds per square inch, which is about 40 per cent of the endurance limit of the base material, as shown by rotating beam tests. The experimental truck frame was found adequate for this design stress and as an additional precaution, all fillets were carefully ground and considerable effort was expended in eliminating abrupt changes in contour.

Cromansil steel, in a .17 carbon grade, shows a yield strength of about 62,000 pounds per square inch, an ultimate strength of 95,000 pounds per square inch, and an elongation in 8 inches of 26 per cent. The carbon content is purposely limited to .17 because of the damage to the higher carbon steels through the welding heat, and while these trucks are thoroughly heat treated after welding, it is possible that at some future date minor repairs or additions might be necessary on the trucks and the low carbon content of the steel assures completion of any such repairs with minimum hazard.

Stress Is Sum of All Forces

While the design stress of 24,000 pounds per square inch may seem to be high, it is the sum of the stresses due to all possible loads that might occur at the same time. Several units of welded railroad equipment have given successful service over a period of years working at this stress. Notable examples are the welded steel underframes in service on the first Burlington Railroad three car "Zephyr" and other high speed streamlined trains, in which the calculated maximum stress is 26,000 pounds per square inch.

Total weight of two pilot trucks, four articulated trucks, six bolsters and six spring planks is 10,710 pounds per 127,000 pound trains, which gives an average weight per truck of 1785 pounds including spring plank and bolster.

Absolute minimum weight was essential in the trucks of these trains, due to the fact that they are to be placed in local service in which express schedule time must be maintained, and the accelerations and decelerations on local service are very frequent. Therefore the inertia of the train must be as low as is consistent with long service life and safety.

TRUSTEES of Battelle Memorial institute, Columbus, O., have established a division of research associates to supplement the work of the regular technical staff. Intensive training in practical research will be offered to young men in selected branches of metallurgy, chemistry, fuels and ceramics. Four appointments as research associates will be available for the year 1936-37. The associates will be expected to devote their entire time to research problems approved by the directors and supervised by members of the institute staff.

Oil Filters Insure Clean Supply of Liquid

(*Concluded from Page* 31)

for cleaning. The filtering element is removable from some models for this purpose. In other models, the elements are kept in a constant condition of cleanliness by contact with a knife blade. This blade may be rotated against the element to remove contamination or the element may be revolved against the blade. Movable elements may be hand operated or driven by a moving part of the machine.

A recently introduced design of oil filter, *Fig. 2E,* adopted for many bus, truck and automobile engines, has an element of igneonite, a porous rocky substance which both filters and clarifies the oil. This is a ceramic development which makes possible a uniformly porous filter element. The action of the filter removes the black discoloration of old oil and restores and maintains its natural color. Dust, dirt, carbon and metal particles are completely removed. When the element becomes clogged with foreign matter, a new element is installed.

A fourth type of oil filter is based on filter packs composed of hundreds of paper washers or disks, 1⅝-inch diameter, with a hole in the center, and specially treated to prevent deterioration, *Fig. 2F.* The disks are stacked upon a central spring and rod under 80 pounds tension, forming a solid column. Oil is forced between the disks (not through them) and passes up the center of the pack into the filter head. Solids and impurities removed in the purification of the oil are stopped at the surface of the packs and do not penetrate the disks. Maximum space between the disks is less than 1/250,000 of an inch.

Operation of this filter continues indefinitely until the percentage of impurities removed from the oil offers resistance to normal flow, when the filter is cleaned. Cleaning is accomplished during operation of the engine by a reverse flow of the fuel oil through the disks, dislodging the solids into a container, after which the filter is ready for service and functions as in the original installation.

In the application of this type of filter to diesel engines, *Fig. 2A,* the fuel discharge pump is connected to the lower header, delivering oil at the required pressure into each of three compartments of the filter-shell. Oil passes through the packs, into the filter head connected in turn to the injector pump.

For their co-operation in the preparation of this article, and for the illustrations used, MACHINE DESIGN wishes to thank A C Spark Plug Co., Cuno Engineering Corp., Motor Improvements Inc., and Skinner Purifiers Inc.

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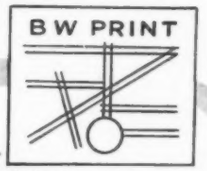

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Self-closing hinge cover for easy filling.

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GITS BROS MANUFACTURING CO.
1861 S. Kilbourn Ave., Chicago

Topics of the Month

(*Concluded from Page* 18)

health, but also aids in reducing that expensive but necessary item in every budget, food. Annual food spoilage, which runs into millions of dollars and which is one indirect cause of high food prices, is largely the result of mold spores. Now Westinghouse Lamp company has developed a new low-wattage gaseous conductor device which produces radiations germicidal to mold spores in the air. Baked goods, treated with these germicidal rays, remain mold-free for longer periods and can be completely consumed before they spoil. Permeating the air of a refrigerator storage room with these rays kills mold spores and spoilage bacteria, and makes it possible to tenderize or "age" meat at higher temperatures without danger of spoilage from mold or putrefaction.

♦ ♦ ♦

Many times in the deep solitude of the woods to the right of the tenth fairway we have wondered, with discouragement heavy upon us, why some engineer did not develop a method that gave definite assurance that every golf ball would fly exactly down the center of the greensward. Now our prayers are answered as Sperry is said to have developed a mace that insures accurate flight of the club head. This club includes a gyroscope which resists any deviation from the correct line of swing. The only disturbing factor is that the gyroscope motor emits a sound which has close similarity to the all-too-familiar Bronx cheer.

♦ ♦ ♦

Still another recent machine which simplifies the process of living is a reading machine. With this unit an entire novel like Anthony Adverse can be reduced to a few feet of film and read off readily. *The New York Times* tells us that the inventor predicts the day when whole libraries will be reduced to films and stored in a few rooms.

♦ ♦ ♦

A substitute for switch and fuse combinations and conventional types of individual circuit breakers is soon to be announced as a tiny low-cost multi-breaker load center. A device of this sort has enormous possibilities, the 1936 market in the housing industry alone being estimated at a half-million such load centers.

♦ ♦ ♦

Despite comparatively recent morbid predictions that power plants would never be able to market the current that they were capable of producing, it now appears that not only will this current be consumed, but also additional building, improvement in generating equipment, and modernization will soon be necessary. Electrical power production has just set another all-time high with output equalling 2,005,243,000 kilowatts. This power output figure is undoubtedly a reflection of improved industrial production, the index of which is now at 101, but can also be attributed to the great advance of domestic machinery, air conditioning, etc. However, the effect of farm electrification has not, as yet, been felt.

MANUFACTURERS' PUBLICATIONS

ALLOYS (IRON)—Chemical and physical properties of commonly used alloys of iron, brass and bronze, the characteristics of these alloys, and typical applications are given in a new reference catalog for engineering purposes of Cramp Brass & Iron Foundries Co., Paschall station, Philadelphia. An interesting table in the bulletin gives the effect of the addition of several elements to the iron.

ALLOYS (NICKEL)—A buyers' guide to warehouse stocks of nickel alloy steels, the steels and shapes carried at these warehouses and other similar data are included in a recent publication of International Nickel Co. Inc., 67 Wall street, New York.

ALLOYS (STEEL)—Joseph T. Ryerson & Son Inc., Sixteenth and Rockwell streets, Chicago, has prepared a most complete 192-page booklet which gives shop data on alloy and tool steels, covering a technical subject in a nontechnical way. This booklet includes heat treating charts, analysis and properties, effects of various elements on alloy steel, and standard specifications in addition to a wealth of information of interest to the engineer specifying and using alloy steels.

BEARING APPLIANCES—Closures in a wide variety of styles for all types of antifriction bearings are presented in bulletin B-50 of R-S Products Corp., 4532 Germantown avenue, Philadelphia. The bulletin gives complete dimensions, details of applications, characteristics of the many types of closures, and other information of value when considering their application.

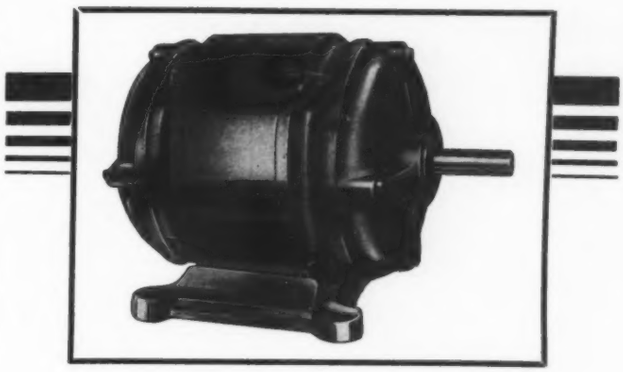
BEARINGS—Detailed drawings showing the application of antifriction bearings to crane parts are included in a most complete booklet of SKF Industries Inc., Philadelphia, entitled "Bearings for Cranes." In addition to these drawings, the booklet includes photographs showing typical applications, and complete tables to aid in the selection of bearings for any particular application.

CAST PARTS—Steel castings of a wide variety of properties for many and varied applications are presented in descriptions and illustrations in a new publication of Farrell-Cheek Steel Co., Sandusky, O.

CONTROLS (ELECTRICAL) — Complete details on Vitrohm field rheostats and accessories are given in bulletins 60A and 60B of Ward Leonard Electric Co., Mount Vernon, N. Y.

CONVEYORS—Silverlink conveyor chains which operate over cut-tooth sprocket wheels are covered in book No. 1552 of Link-Belt Co., Indianapolis. The catalog gives complete dimensions, weights and ultimate strengths, and a tabulation of cut-tooth sprocket wheels available for each size of chain. Many styles of attachments including flat-top type and chain with extended pins are available.

COUNTERS—Production Instrument Co., 1319 South



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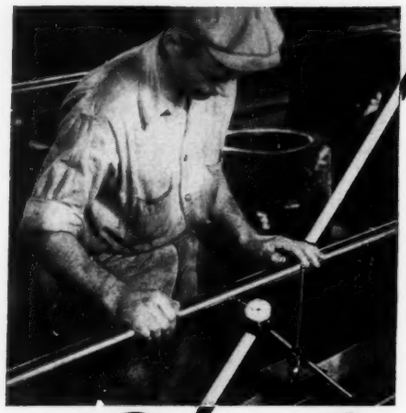

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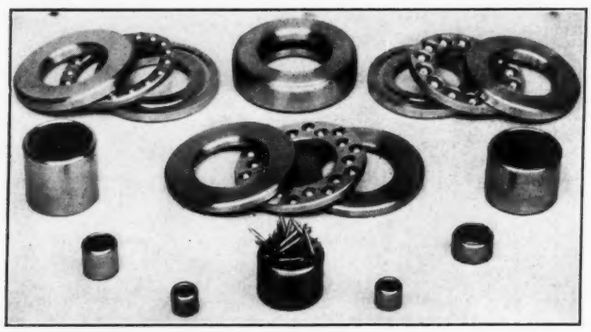

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THE BANTAM BALL BEARING CO.
SOUTH BEND, INDIANA

BBB TAKE YOUR TOUGHEST BEARING JOB TO BANTAM

Wabash avenue, Chicago, has prepared bulletin 16 which gives complete details on the company's line of high speed electric counters which may be actuated by photoelectric relays, ordinary switches, periodic circuits, or special-purpose sensitive switches.

DRIVES—Sterling Electric Motors, Telegraph road, Los Angeles, is distributing a new bulletin on its line of motorized units for obtaining infinite speed variation. The bulletin includes a presentation of the various mounting arrangements available.

DRIVES—Link-Belt Co., Indianapolis, has published a new 24-page book, No. 1557, in which are tabulated the many cut-tooth sprocket wheels which are now available with Silverlink finished-steel roller chains from stock. The new book simplifies the ordering of a wheel, piece of chain, or a complete drive by providing complete and easily read tables.

DRIVES — A revised listing of a large number of V-belts available in nonstandard sizes on the V-mold equipment of L. H. Gilmer Co., Tacony, Philadelphia, is presented in a new publication of the company. Among standard belts are included 31 sizes in ⅜ by ¼-inch cross section. A new endless round belt and special flat belts in a range of sizes are shown.

ELEMENTS—The 92 elements, their characteristics and data relating to X-ray work are completely presented in a new folder of St. John X-Ray Service Inc., 30-20 Thomson avenue, Long Island City, N. Y.

FASTENINGS—Bristol Co., Waterbury, Conn., has prepared a folder which gives complete dimensions and characteristics of its line of socket set screws and socket head cap screws. Another publication of the company gives American standards for socket set screws and socket head cap screws including dimensions of hexagonal and fluted socket heads, screw and thread lengths, screw points and wrenches to match.

LUBRICATION AND LUBRICATING EQUIPMENT—Characteristics of Lubriplate, a lubricant which maintains a film on the surface treated, are completely given in a new folder of Fiske Bros. Refining Co., 24 State street, New York.

MOTORS—Back-geared, worm drive flea powered motors manufactured by Speedway Mfg Co., 1834 South Fifty-second avenue, Cicero, Ill., are illustrated and described in a folder of the company which gives complete details on the motors.

NOZZLES—Nonclogging spray nozzles which can be built into machinery for spraying, washing, and cleaning all kinds of materials, screens, fruit, vegetables, etc., and for a wide variety of other uses are covered by folder No. 1407 of Link-Belt Co., Chicago.

PACKING GLANDS AND PACKING—General information on the construction and operation of the rotary type seal as well as various typical applications is covered in a new bulletin of Rotary Seal Co., 803 West Madison street, Chicago. This bulletin is designed to acquaint engineers and designers with the possible arrangements of the seal which can be built into the design.

PLASTICS—General Plastics Inc., North Tonawanda, N. Y., has just published a 28-page book which gives

physical properties of all of the standard Durez phenolic molding materials, including blacks and colors. Designed for molders, manufacturers having molding equipment and those buying molded parts, the book also includes data on molding technique and part design.

PUMPS—Artra Pump Co. Inc., 75 Fremont street, San Francisco, is distributing a folder on its line of positive displacement, rotary type units for the transfer of thin or thick liquids, gases, vapor or vacuum. The pumping units are self-priming.

PUMPS—Steel City Electric Co., Pittsburgh, has prepared a bulletin on its new line of vacuum or air pumps which include the motor and pump as a combined unit. The combined unit is about the same size and weight as a standard motor and its base.

REFRACTORIES—A 48-page manual of information of refractories, including tabular material of interest to engineers whose use of refractory materials requires specific formulas, has just been published by Standard Fuel Engineering Co., 667 South Post avenue, Detroit.

WELDED PARTS AND EQUIPMENT—Improved flame cutting machines capable of cutting a variety of intricate shapes from plate steel are described in a bulletin of Schoitz Tool, Gear & Machine Works, Waterloo, Ia. Typical parts cut by the machine are presented.

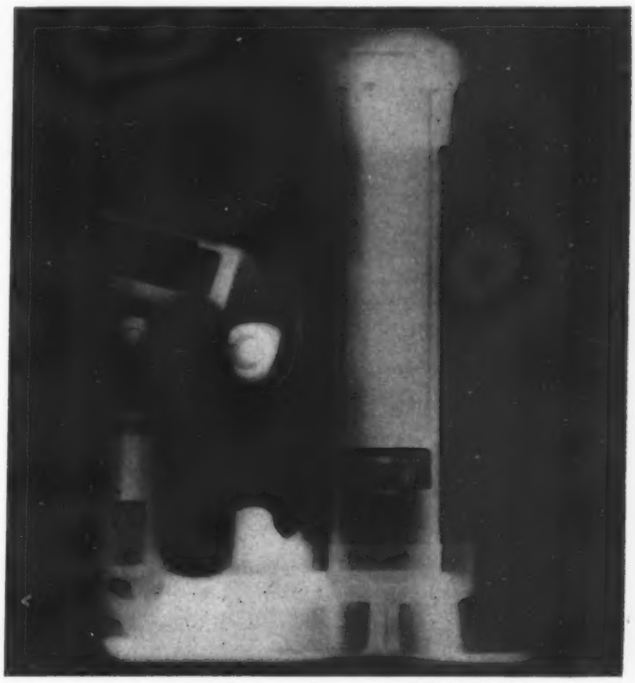
WELDED PARTS AND EQUIPMENT—An interesting booklet recently prepared by Lincoln Electric Co., Cleveland, gives valuable advice on manufacturing by arc welding. Advantages of this design procedure, typical parts manufactured, and how these parts are fabricated by the process are included in the publication.

WELDED PARTS AND EQUIPMENT—Data necessary for producing arc welded designs is presented in concise ready-reference form in the new engineering design room chart of Lincoln Electric Co., Cleveland. The chart gives weld symbols, types of joints, suggestions for better arc welded design, nomenclature of welds, safe allowable loads for fillet welds in shear, and tables of properties and length of fillet weld as compared with rivets.

Research Publications

Researches in High-Pressure Steam, by A. A. Potter, H. L Solberg, and G. A. Hawkins. Although maximum steam boiler pressures in use in power plants in the United States have increased during the last fifteen years from 400 to 1400 pounds per square inch, the basic design of boilers has remained unchanged. While it may be possible to build boilers of conventional design for even higher pressures, it is desirable from the standpoint of plant investment to develop a steam generator in which expensive forged drums and other pressure parts of large volume would be reduced to a minimum. Moreover, at higher pressures, the decreased difference between the density of water and steam intensified the problem of adequate natural circulation through tubes subjected to high rates of heat transfer. The experimental forced-circulation, once-through, high-pressure steam generator was designed and built to eliminate some of the features of the standard type of boilers which are considered most objectionable at the higher pressures. Published by Engineering Experiment station, Purdue university, Lafayette, Ind., as research series No. 52. 17 pp.

X-RAY SPOTLIGHTS
THE PACKING POINT*
that can make or break your design



Graton & Knight packing engineers are ready to contribute their "X-ray thinking" to your design—when you reach the Packing Point.* You can save yourself trouble, and make sure the packing will cause no hitches in production by calling us in at an early stage in your design. On the tightness of the closure, with freedom of motion for moving parts, depends the efficient operation of all kinds of machines—from a hydraulic jack (pictured in the X-ray here) to a giant press.

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Okay from the Underwriters demanded 100% exclusion of oil by the packing—yet room for the rod to operate with ease. The designer feared his design was doomed, for no available packing came up to specifications. But he called in Graton & Knight, who solved the problem with special leather packing designed to fit the job.

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proof motors may be removed from the reducer without disturbing the underwriters label, due to a patented feature in the method of mounting motor on reducer. This feature is used in all sizes and styles. It provides free floating of the motor shaft and eliminates the possibility of oil entering the motor.

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Business and Sales Briefs . . . . . .

CO-ORDINATION of the activities of the plastics department under the direction of vice president C. E. Wilson has been announced by General Electric Co. C. K. Mead has been placed in charge of a newly formed Insulation, Glyptal and Plastics sales section of the Appliance and Merchandise department with headquarters at Bridgeport, Conn. The newly formed section, besides assuming responsibility for plastics sales, will carry on the activities of the former miscellaneous sales section. It will be under the general direction of J. H. Crawford, manager of construction materials sales. R. E. Coleman, manager of the Plastics department, has been transferred to the Appliance and Merchandise department and will report directly to Mr. Wilson, as will G. H. Shill who has been placed in charge of the manufacturing and engineering activities of the Plastics department.

* * *

The Los Angeles sales office of Cutler-Hammer Inc., Milwaukee, has been moved to new quarters at 1331 Santa Fe avenue, Los Angeles. This office is in charge of W. G. Tapping. A complete stock of standardized motor control, safety switches and electrical specialties will be carried at the new address.

* * *

Edward A. Livingstone is now manager of alloy tube sales for Babcock & Wilcox Tube Co., Beaver Falls, Pa.

* * *

Charles L. Spatholt has been appointed district sales manager at Milwaukee for Truscon Steel Co., Youngstown, O.

* * *

Charles Bruning Co. Inc., has established a new branch at Kansas City, Mo., with Norman B. McKinnon, formerly of the Pittsburgh office, as manager. The new branch is located at 1320 Walnut street.

* * *

Brammer Machine & Tool Service, 104 Tulsa building, Tulsa, Okla., has been appointed to handle the line of cutting tools, cemented tungsten carbide tools, gear finishing, lapping and checking equipment manufactured by Michigan Tool Co., in Kansas, Oklahoma, and Northern Texas.

* * *

F. P. Shephard is now district sales manager of the Cleveland office of Haynes Stellite Co., succeeding W. A. Moore, deceased. Mr. Shephard has been sales engineer in the Chicago office of the company for the past nine years.

* * *

Carnegie-Illinois Steel Corp. and American Sheet & Tin Plate Co. have announced the following district sales managers who will have charge of merchandising all products of the combined companies: In the Birmingham, Ala., sales district Meryl H. Geisking will be in charge; Boston, Wilbur Sargent Locke; Chicago, David F. Austin; Cincinnati, L. K. Slaback; Cleveland, Francis C. Hardie; Denver,

Herbert E. Fryer; Detroit, P. M. Guba; Houston, Tex., E. E. Aldous; Milwaukee, John R. Johnston; New York, James R. Mills; Philadelphia, E. K. Bauer; Pittsburgh, Thomas J. Hilliard; St. Louis, Robert Korsan Jr.; St. Paul, L. B. Worthington, and Washington, D. C., H. F. Knapp. A new sales district with headquarters at Indianapolis has been established in Indiana. W. E. Blackburn is in charge of this district.

* * *

Carl H. Morken has been appointed director of engineering sales for Carondelet Foundry Co., St. Louis. Since 1930 Mr. Morken has been foundry engineer of Detroit Electric Furnace Co., Detroit.

* * *

Republic Steel Corp., Cleveland, has added the names of W. L. Blake Co., Portland, Me., and Hunter & Havens, Bridgeport, Conn., to its list of distributors of Toncan copper molybdenum iron sheets. Toncan iron sheets will be handled in addition to the supply of Toncan iron pipe which W. L. Blake company has distributed for the past two years.

* * *

George M. Snodgrass has been appointed general sales manager of Imperial Electric Co., Akron, O., manufacturer of electric motors and generators. For the past fifteen years Mr. Snodgrass has been with Fairbanks, Morse & Co. where he held the position of general sales manager of the electrical division.

* * *

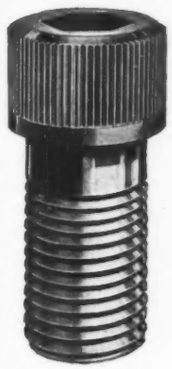
Oliver C. Henkel has been appointed district sales manager in the New York metropolitan area for Empire Sheet & Tin Plate Co., Mansfield, O. Mr. Henkel has been connected with the Empire company for the past five years, recently serving in the capacity of sales promotion engineer and advertising manager.

* * *

Lincoln Electric Co., Cleveland, manufacturer of welders, electrodes and motors, has appointed Intermountain Belting and Packing Co. as its agent in Denver, Colo., covering the State of Colorado and part of Kansas, Nebraska and Wyoming. Headquarters of the company are located at 1414 Wazee street, Denver. J. H. Johnson, president of the Intermountain company, M. H. Mickey, vice president, J. I. Creighton, secretary, Homer Glan and James Kelley will represent the Lincoln company.

* * *

L. W. Briggs, who resigned recently as general manager of sales of West Leechburg Steel Co., has been made vice president in charge of sales for Superior Steel Corp., Pittsburgh, succeeding William P. Ewing. Mr. Ewing has been promoted to executive vice president, a newly created office. Norman D. Carpenter, formerly traffic manager and later identified with sales work for the West Leechburg company, has been appointed assistant vice president of the Superior company. Walter G. Blume is now manager of stainless steel sales and John D. Kerr is manager of carbon steel sales for the Superior Steel Corp. Both Mr. Blume and Mr. Kerr were formerly employed by the West Leechburg Steel Co., Mr. Blume as assistant general manager of sales and Mr. Kerr as a member of the general sales department. Kenneth W. Massey has been appointed manager of development and research for the Superior company.



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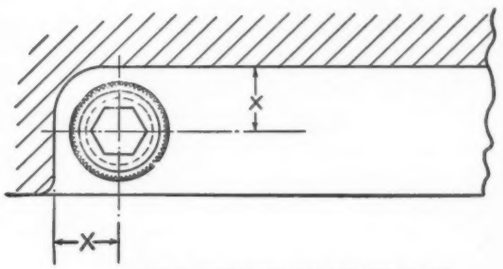
KNURLED "UNBRAKO"
SOCKET CAP

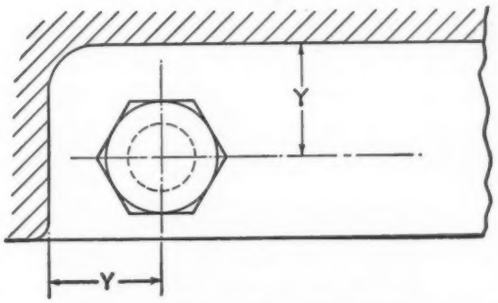
KNURLED

UNBRAKO

for COMPACT DESIGNS



See how the Knurled "Unbrako" snuggles right into the corner.



Notice the great open spaces necessary for the hex-head and wrench.

The difference between "X" and "Y" in line cuts demonstrates the decided saving in Clearance, Material, Weight and Cost made possible by using the Knurled "Unbrako" Socket Head Cap Screw.

Don't pooh! pooh! these advantages as they may help to make difficult designs easier and much more compact.

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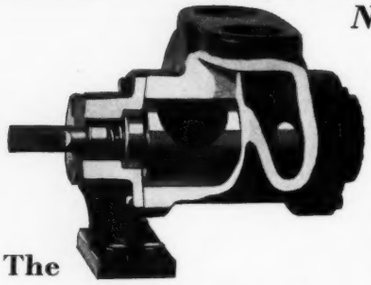

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Rotary Reciprocating
PISTON PUMP

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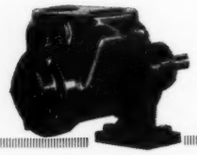

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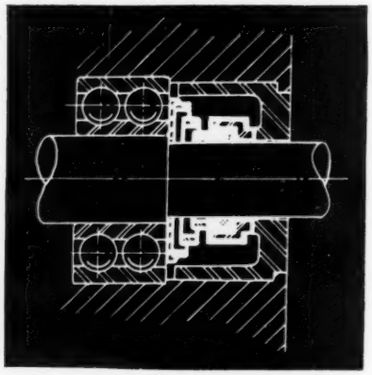

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—SIMPLE IN CONSTRUCTION—
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INDEX TO ADVERTISERS

Allen-Bradley Co.	3
Allis-Chalmers Mfg. Co.	*
Bantam Ball Bearing Co.	76
Bearings Company of America	*
Bethlehem Steel Co.	*
Bliss & Laughlin Inc.	76
Bodine Electric Co.	*
Booth Felt Co.	78
Boston Gear Works Inc.	*
Brown & Sharpe Mfg. Co.	72
Bruning, Charles, Co., Inc.	73
Carpenter Steel Co.	12, 13
Century Electric Co.	55
Chicago Molded Products Corp.	68
Chicago Rawhide Mfg. Co.	4
Cleveland Worm & Gear Co.	56
Climax Molybdenum Co.	53
Conway Clutch Co.	*
Cumberland Steel Co.	72
Cutler-Hammer Inc.	Back Cover
Diamond Chain & Mfg. Co.	*
Dietzgen, Eugene, Co.	*
Drop Forging Association	67
Dumore Co.	*
Emerson Electric Co.	*
Electro Metallurgical Co.	61
Fafnir Bearing Co.	59
Fairbanks, Morse & Co.	17
Farval Corp.	*
Felters Co. Inc.	64
Foote Gear Works Inc.	78
Formica Insulation Co.	*
Garlock Packing Co.	*
General Electric Co.	10, 11
General Electric Vapor Lamp Co.	*
Gibson, Wm. D., Co.	*
Gits Bros. Mfg. Co.	74
Globe Products Co.	80
Graton & Knight Co.	77
Hoover Ball & Bearing Co.	*
Hyatt Roller Bearing Co.	65
International Nickel Co.	57
James, D. O., Mfg. Co.	*
Laminated Shim Co. Inc.	66
Leiman Bros.	70
Lincoln Electric Co.	*
Linde Air Products Co.	8
Link-Belt Co.	*
Lovejoy Tool Works	74
Marlin Rockwell Corp.	49
Master Electric Co.	9
Morse Chain Co.	*
National Motor Bearing Co. Inc.	*
New Departure Mfg. Co.	6
New Jersey Zinc Co.	82
Norma Hoffmann Bearings Corp.	52
Pease, C. F., Co.	*
Peerless Electric Co.	60
Philadelphia Gear Works	14
Production Instrument Co.	*
Reeves Pulley Co.	*
Roots-Connersville Blower Co.	*
Roper, Geo. D., Corp.	*
Rotary Seal Co.	80
Shafer Bearing Corp.	71
Shakeproof Lock Washer Co.	Inside Front Cover
Sherwin-Williams Co.	19
Speedway Mfg. Co.	70
Spring Washer Industry	81
Standard Pressed Steel Co.	79
Summerill Tubing Co.	*
Thompson-Bremer & Co.	Inside Back Cover
Timken Roller Bearing Co.	63
Tinnerman Stove & Range Co.	*
Twin Disc Clutch Co.	62
Union Carbide & Carbon Corp.	8, 61
United States Steel Corp.	16
Valley Electric Corp.	75
Veeder-Root Inc.	51
Vickers Inc.	*
Viking Pump Co.	64
Wagner Electric Co.	58
Waldron, John, Corp.	66
Waukesha Foundry Co.	68
Wellman Bronze & Aluminum Co.	20
Westinghouse Electric & Mfg. Co.	15
Whitney Chain & Mfg. Co.	54
Wilmington Fibre Specialty Co.	*

*Advertisements appear in previous issues.